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Measurement of Automatic Enhancement performance of Abdomen x-ray images using Automatic Scoring

Ali H. A. Gesmallah[1], SuhaibAlameen[2], Mohamed E. M. Gar-Elnabi[2]
[1]Sudan Academy of Sciences, P.O Box 86 Khartoum, Sudan
[2]Sudan University of Science and Technology. College of Medical Radiologic Science,P.O.Box 1908, Khartoum, Sudan
Corresponding Author: Ali Hayder

Abstract:*This study aimed to automatic scoring of performance test in conventional diagnostic x-rays where its done in alkuity hospital and Daralelag 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 abdomen X.ray (KUB).The study resultsshow that the enhancement of image quality affected 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,abdomen, X-ray,*

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I. Introduction:

Currently, X-ray imaging system has been widely used in medical imaging and industrial nondestructive testing and other fields. X-ray image quality directly affects the diagnostic results. In traditional X-ray imaging process, the operator repeatedly adjusts the tube voltage and tube current and select the best parameter value which defined by her or his experiences at last [1]. This is a subjective model depends on the operator's judgments. This model is not only inefficient, time poor, but also requires relatively high professional quality of the operator. At the same time, because this process is very similar to the process of focusing the camera.

Therefore, it's very important of study an X-ray image quality objective evaluation method, and feedback control tube voltage and tube current based on the evaluation result, to complete the "focusing-like" process automatically.

A CAD system generally consists of four stages of preprocessing, image segmentation, feature extraction, and classification of features [2]. Preprocessing in the CAD system significantly affects other stages. Effective preprocessing decreases the error rate in the next steps, and thus, the total number of errors in the system is reduced. With proper preprocessing, the minimum number can be selected as primary suspected MCCs; this would accelerate the classification stage.

Each year, more than 20 million diagnostic x-ray procedures are performed in Canada. Although the radiation exposure connected with these procedures cannot be avoided, there are means to reduce it as much as possible. For the protection of patients, workers and the public for example, federal and provincial government agencies enact legislation and take necessary steps to ensure that only safe and properly installed x-ray equipment is used in Canadian diagnostic x-rayfacilities, for the protection of patients, workers and the public. Also, in most provinces [3,4,5,6,7]. and in federal institutions 10 there is a requirement that each diagnostic x-ray facility have in place a basic quality assurance (QA) program to control the quality of diagnostic images. Many enhancement methods are used to improve thevisual appearance of x-ray images [8-11].Therefore, improve medical diagnosis to acquire good quality images so that the doctors can make use of these images toarrive correct conclusions. Imageenhancement techniques are interested in improving the appearance of an image without referring to the conditionsof image degradation process [12].The proposed method in this study included seven stages. the images were measured at signal white before and after, then measure the noise white before and after, signal to noise white before and after, signal black before and after, Noise black before and after, Signal to noise black before and after, finally measure the contrast before and after.

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 filtration: 2.5 AL/75, 0.6 IEC 60336, NOMINAL VOLTAGE 150 KV 1.2 IEC 60336.

This study will achieve Elkawitey 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 cases of abdomen X.ray(KUB).

Patient position and technique for abdomen:

The abdominal cavity extends from the under surface of the diaphragm above to the pelvic inlet below and is contained by the muscles of the abdominal walls.

To mark the surface anatomy of the viscera, the abdomen is divided into nine regions by two transverse planes and two parasagittal (or vertical) planes.

The upper transverse plane, called the transpyloric plane, is midway between the suprasternal notch and the symphysis pubis, approximately midway between the upper border of the xiphisternum and the umbilicus. Posteriorly, it passes through the body of the first lumbar vertebra near its lower border; anteriorly, it passes through the tips of the right and left ninth costal cartilages. The lower transverse plane, called the trans tubercular plane, is at the level of the tubercles of the iliac crest anteriorly and near the upper border of the fifth lumbar vertebra posteriorly. The two parasagittal planes are at right-angles to the two transverse planes. They run vertically, passing through a point midway between the anterior superior iliac spine and the symphysis pubis on each side. These planes divide the abdomen into nine regions centrally from above to below epigastric, umbilical and hypogastric regions and laterally from above to below right and left hypochondriac, lumbar and iliac regions. The pelvic cavity is continuous with the abdominal cavity at the pelvic inlet, extends inferiorly to the muscles of the pelvic floor, and is contained within the bony pelvis. Although viscera are said to occupy certain regions of the abdomen, and surface markings can be stated, it must be remembered that surface markings of viscera are variable, particularly those organs that are suspended by a mesentery. (15)

Although the radiographic technique used will depend on the condition of the patient, there are a number of requirements common to any plain radiography of the abdomen and pelvic cavity. Maximum image sharpness and contrast must be obtained so that adjacent soft tissues can be differentiated. Radiography is normally performed using a standard imaging table with a moving grid. However, depending on the condition of the patient, imaging may be performed using a stationary grid either on a patient transport trolley or on the ward using a mobile X-ray machine. The patient should be immobilized, and exposure is made on arrested respiration, usually after full expiration. Coverage of the whole abdomen to include diaphragm to symphysis pubis and lateral preperitoneal fat stripe for the acute abdomen. Visualization of the whole of the urinary tract (kidneys, ureters and bladder – KUB). Visually sharp reproduction of the bones and the interface between air-filled bowel and surrounding soft tissues with no overlying artefacts, e.g. clothing. In calculus disease, good tissue differentiation is essential to visualize small or low-opacity stones. Radiation protection the 'pregnancy rule' should be observed unless it has been decided to ignore it in the case of an emergency. Gonad shielding can be used, but not when there is a possibility that important radiological signs may be hidden.

Strict application of the 'pregnancy rule' or the 'ten-day rule' is important in females of childbearing age. For males, the correct size of gonad protection should be selected and applied carefully so the gonads are shielded and the pelvic region not obscured with lead. (15)

III. Results:

Table 1. show Descriptive Statistics for image quality parameters:

	Min	Max	Mean	Std. Deviation
signal white BF	449	2295	1360.22	442.845
noise white BF	21	48	36.37	6.062
signal to noise white BF	21	48	36.37	6.062
signal black BF	104	1285	455.94	209.220
Noise black BF	10	36	20.80	4.669
Signal to noise black BF	10	36	20.80	4.669
Contrast BF	0	1	0.53	0.502
Signal white AF	283	2295	1734.31	523.064
Noise white AF	17	48	41.08	7.016
Signal to noise white AF	17	48	41.08	7.016
Signal black AF	3	1783	505.20	374.952
Noise black AF	2	42	20.98	8.226
Signal to noise black AF	2	42	20.98	8.226
Contrast AF	0	1	0.63	0.486

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

		Correlation	P.value
Pair 1	signal white BF & Signal white AF	0.686	.000
Pair 2	noise white BF & Noise white AF	.686	.000
Pair 3	signal black BF & Signal black AF	.658	.000
Pair 4	Noise black BF & Noise black AF	.640	.000
Pair 5	signal to noise white BF & Signal to noise white AF	.686	.000
Pair 6	Signal to noise black BF & Signal to noise black AF	.640	.000
Pair 7	Contrast BF & Contrast AF	.478	.000

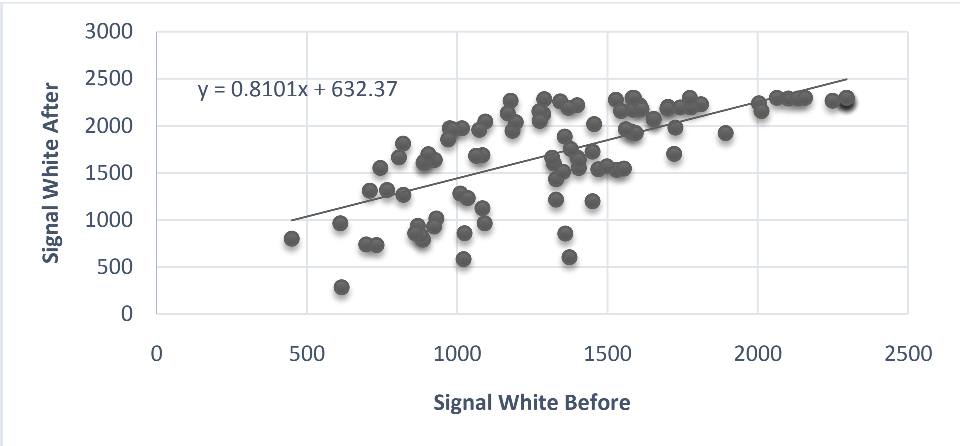

Figure 1. show correlation between the signal white before and after

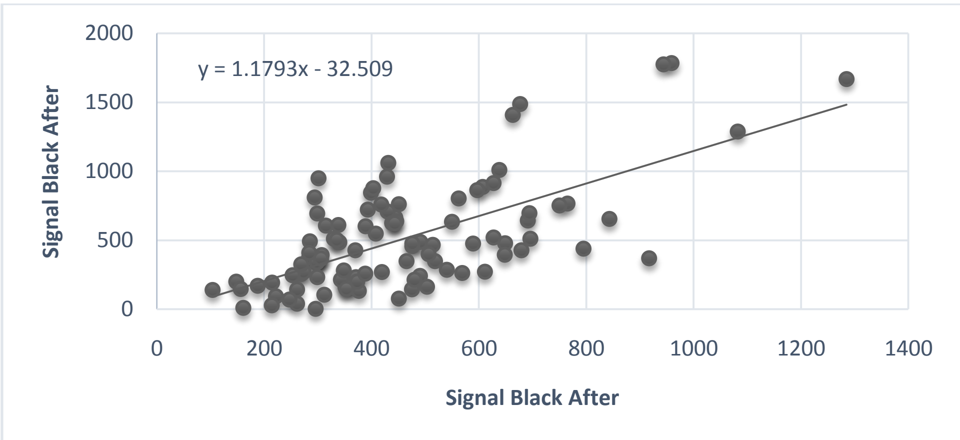

Figure 2. show correlation between the signal black before and after

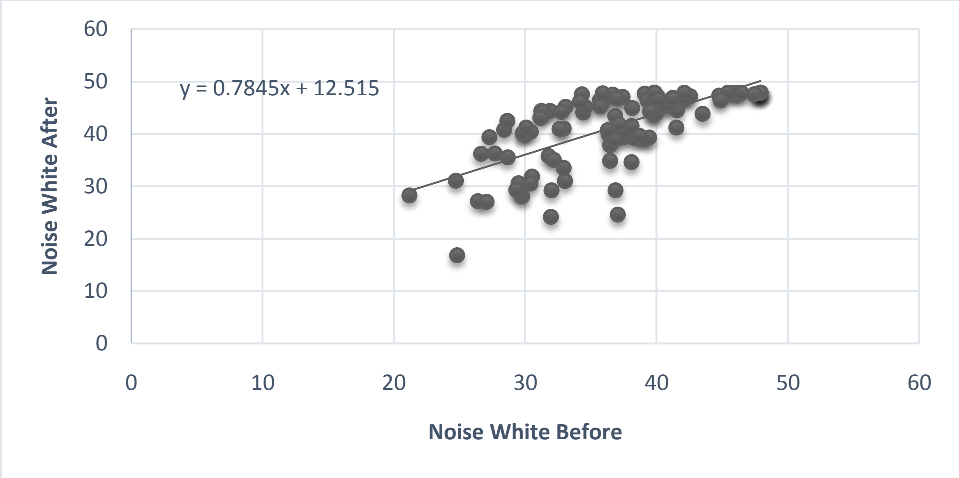

Figure 3. show correlation between the noise white before and after

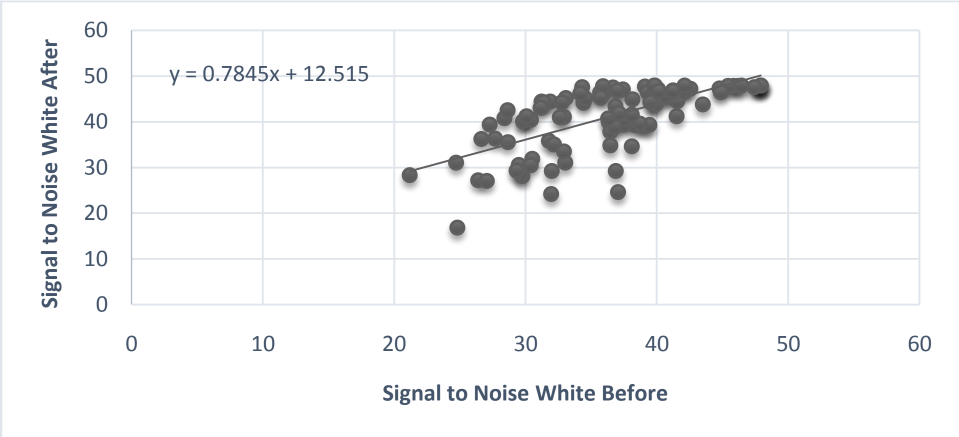

Figure 4. show correlation between the signal to noise white before and after

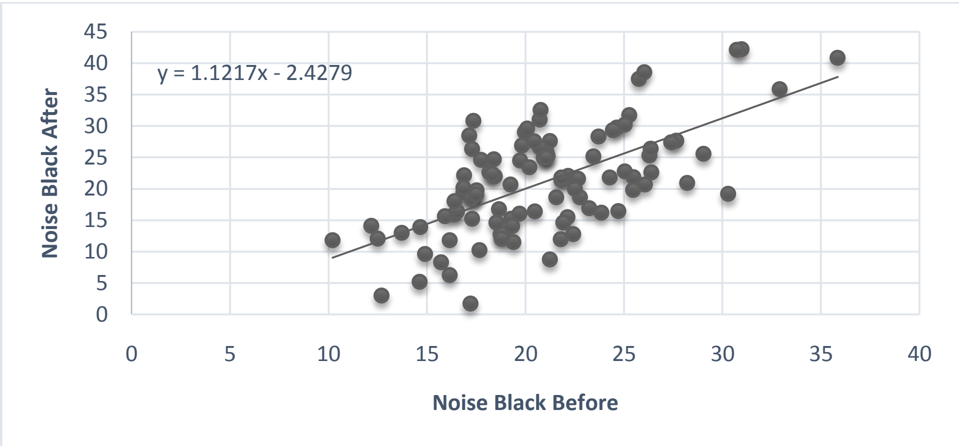

Figure 5. show correlation between the noise black before and after

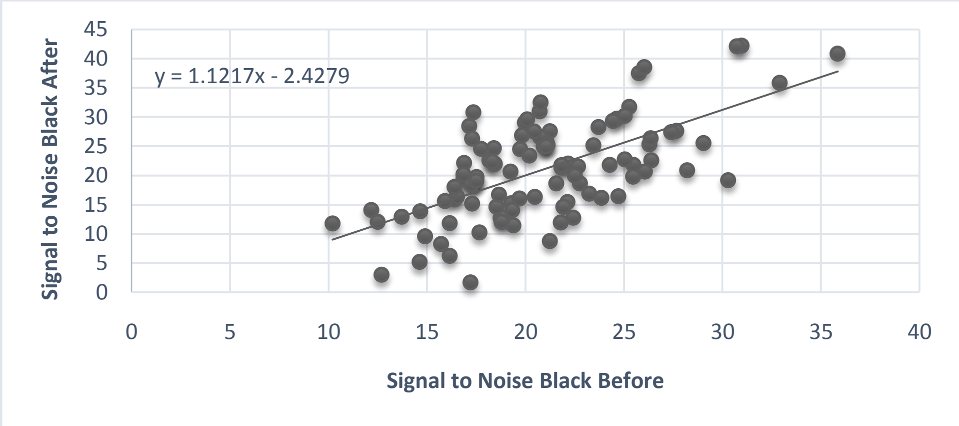

Figure 6. show correlation between the signal to noise black before and after

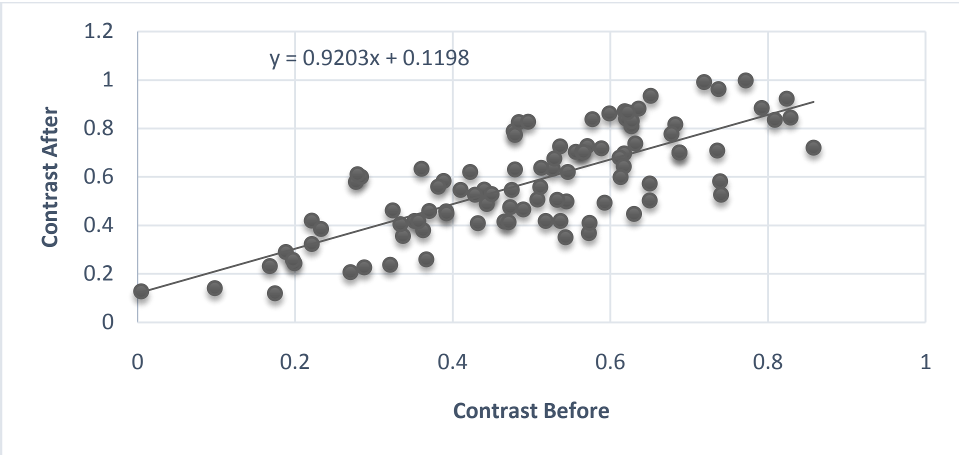

Figure 7. show correlation between the contrast before and after

IV. Discussion:

automatic scoring of performance test in conventional diagnostic x-rays to patients examined for abdomen shows as Mean ±SD for all image quality parameters. Where the mean ± std for signal white before and after enhancement was 1360.22±442.845 and 1734±523.064, and noise white before and after was 36.37±6.062 and 41.08±7.016, signal to noise white before and after 36.37±6.062 and 41.08±7.016, the signal black before and after enhancement was 455.95±209.220 and 505.20±374.952, while the noise black before and after was 20.80±4.669 and 20.98±8.226, and the signal to noise black before and after was 20.80±4.669 and 20.98±8.226, and lastly the contrast before and after enhancement 0.53±0.502 and 0.63±0.486. 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 0.686, and noise white BF & Noise white AF showed strong relationship 0.686, pair 3 signal black BF & Signal black AF with strong relation 0.658, while Noise black BF & Noise black AF showed slight decrease from the other parameters 0.460. the signal to noise white BF & Signal to noise white AF showed strong relation 0.686, Signal to noise black BF & Signal to noise black AF was 0.686 and the Contrast BF & Contrast AF showed lower values than the other parameters with 478. 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 0.7845 till 1.1793 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 abdomen X.ray(KUB).

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 = 0.8010 (signal white before) + 632.37
Signal black after = 1.1793 (signal black before) - 32.509
Noise white after = 0.7845 (noise white before) + 12.515
Signal to noise white after = 0.7845 (signal to noise white before) + 12.515
Noise black after = 1.1217 (noise black before) – 2.4279
Signal to noise black after = 1.1217 (signal to noise black before) – 2.4279
Contrast after = 0.9203 (contrast before) + 0.1198

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