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A Novel Approach for Area of Interest Enhancement in X-ray Image

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Abstract:
X-ray image enhancement has been a hot topic in recent era. After de-noising the X-ray image, sometime it is required to increase the contrast of whole image or the specific area because of noise reduction process. In this research work, area of interest enhancement approach for image contrast enhancement is used. The experiments applied on a real medical X-ray images establish that the proposed approach much reliable, robust and computationally simple and very much effective in further image processing phases.
Keywords: Histogram Equalization; Area of Interest Processing; Image Enhancement; Wiener Filter

I. INTRODUCTION

Pre-processing of X-ray images is a very important prospective. Without efficient pre-processing, we can't get best results from post-processing. Image de-noising is one of the most important prospective of pre-processing. There are many ways to de-noise an image or a set of data and methods exists. The important property of a good image de-noising model is that it should completely remove noise as far as possible as well as preserve edges. The most important point is to enhance the image in an efficient way. Histogram equalization is a common approach for de-noise image enhancement but histogram equalization has limitation that it brightens all pixels in the image and sometime the brighter area of the image get brighter. Khan et al. (2013) and Khan and Wang (2012) used histogram specification approach for image enhancement but this approach also has some limitation and complexity. In this research work, area of interest enhancement approach for image contrast enhancement is used.

The rest of the paper is organized as follows:-

- In the second section, we present different enhancement techniques used for digital images.
- In the third section, we described our proposed approach for area of interest enhancement.
- Section 4 illustrates the simulation results and discussion.
- Section 5 presents conclusion and future work.
- Section 6 contains references.

II. BACKGOROUNG STUDY

In X-ray images, contrast is measured by its dynamic range, which is defined as the ratio between the brightest and the darkest pixel gray scale values. Contrast enhancement approaches have a range of application areas for enhancing visual quality of low contrast images. Histogram equalization (HE) is a most popular approach for enhancing the contrast of an image (Umbaugh, 1998). Its basic idea lies on mapping the gray

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levels based on the probability distribution of the input gray levels. It flattens and stretches the dynamic range of the image's histogram, resulting in overall contrast improvement. HE has been applied in various fields such as medical image processing and radar image processing (Kim, 1997). In theory, it can be shown that the mean brightness of the histogram-equalized image is always the middle gray level regardless of the input mean. When brightness preservation is important and necessary, this property is not a desirable one in certain applications.

In general, the range of light luminance the human eye can sense is much larger than the dynamic range of most digital cameras and display devices. And the human visual system also has the brightness adaptation ability, it accomplishes the large variation by changes in the overall sensitivity (Tumblin et al., 1999; Ward, 1994). However, the range of light brightness we can produce by the cameras or image sensors spans at a very limited dynamic range. It means that we will lose the detail information in either light or dark areas when we take a photo in the scenes with dark shadows and bright light sources, i.e., it has high dynamic range. Obviously, some enhancement methods are necessary for improving the photos effectively (ward, 1998; Reihard et al., 2002). Table 1at the end of the paper shows different approaches used for image enhancement in brief.

III. PROPOSED APPROACH

The proposed approach consists of 3 phases.

a. Area of Interest Arrangement

Area of interest arrangement refers to the sub area of the X-ray image which is intended to be filtered and implement specific operations on that area. The proposed work calculates an area of interest by generating a *binary mask.* The grayscale values which describe the area of interest are fixed to “1” and all other pixels fixed to “0”. Researcher can create more than one 64 area of interest in an image. The areas can be the whole image or it can be prompt through a range of intensities.

b. Mask Generation in Area of Interest

This section defines how to generate binary masks to outline area of interest. However, researcher can use every binary image as a binary mask if there is no size issue, i.e. size of binary image and filtered image will be the same. For example, researcher will be intended to filter the grayscale X-ray image “X” and filters only those grayscale values which cross the threshold “0.4”. The „create Mask method‟ is applied to generate a binary mask for any type of object with area of interest. This “create Mask method” produces a binary X-ray image having equal size to the input X-ray image.

c. Area of Interest Filtration

Filtering the area of interest is a simple process. A filter function is applied to an area of interest in an X-ray image. For example, an intensity adjustment filter is applied to a specific area of an X-ray image. To filter an area of interest in an X-ray image, “roifilt2” command of Matlab 2009a is used. When “roifilt2” is invoked, it means:

a. Grayscale X-ray image to be filtered
b. Binary mask X-ray image that create the area of interest and
c. Filter

d. Updating Area of Interest

Updating is a procedure that edits or fills the area of interest of X-ray image by adding the grayscale values from the boundaries of the region. To update or to fill area of interest, “roifill” method is used. This method is valuable for X-ray images editing, including removal 65 of inessential information. This method fills the area of interest with given values on the boundary of the area. If area of interest with the mouse is selected, “roifill” returns an X-ray image with the selected filled area of interest. Finally, researcher just adjusts the whole contrast. Figure 3.1 illustrates area of interest enhancement approach.

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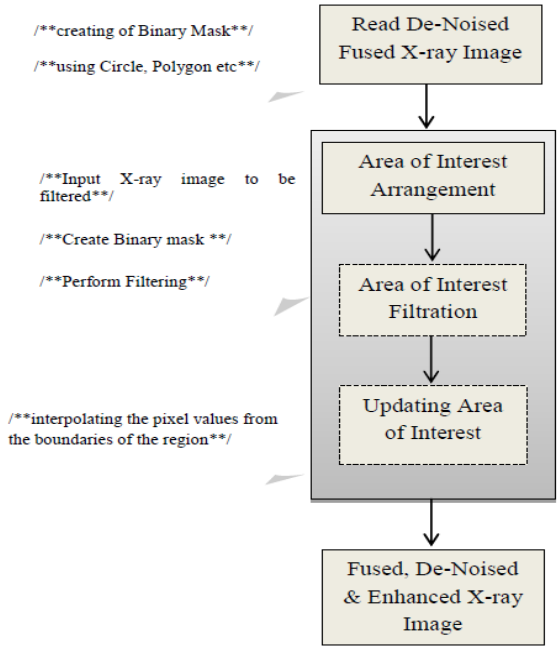

Fig. 3.1 Illustration of area of interest enhancement

IV. SIMULATION RESULTS AND DISCUSSION

The data, which consist of 50 X-ray images, has been collected from the

i. Pakistan Civil Aviation Authority (PCAA) Pakistan, and
ii. Department of Computer Science, School of Engineering, Pontifical Catholic University of Chili. The details of these images are as under:

X-ray images dataset contains original grayscale X-ray images with different noise types and densities and simulated X-ray images in Matlab R2009a as well. These images are in different size of 256*256, 512*512 and with 850*850, 1012*1012. These X-ray images are contaminated with Gaussian noise, Speckle noise, Salt & Pepper noise and Poisson noise with 70% noise density. The research work De-noised those X-ray images using Mean filter, Median filter, order filter and Wiener filter and comparisons among them. The simulation is done using Matlab R2009a.

Table 2 shows the results for different types of noise. After enhancing each image by using different techniques, we compute the Mean Square Error (MSE) and Peak Signal to Noise Ratio (PNSR) to compare the results.

The results in the table 4.1 and Figure 4.1 show that our proposed approach provides best results among others related approaches.

Technique / Noise Type	**Histogram Equalization**	**Histogram Specification**	**Proposed**
Impulse Noise Degraded Image	MSE: 26.2528 PNSR: 35.9730	MSE: 20.7206 PNSR: 36.0008	MSE: 17.0419 PNSR: 39.8444
Poisson Noise Degraded Image	MSE: 18.3811 PNSR: 39.7895	MSE: 16.1122 PNSR: 42.9182	MSE: 13.8589 PNSR: 49.5620
Speckle Noise Degraded Image	MSE: 38.7873 PNSR: 34.2779	MSE: 21.1472 PNSR: 35.8153	MSE: 18.5806 PNSR: 42.7944
Mixed Noise Degraded Image	MSE: 27.9725 PNSR: 37.4032	MSE: 19.8968 PNSR: 37.8867	MSE: 16.5660 PNSR: 38.6303

TABLE 4.1 shows the results of different techniques used for image enhancement

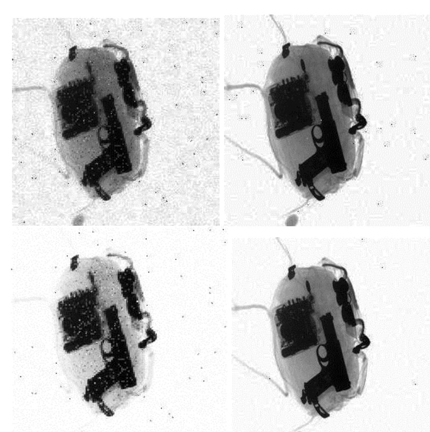

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Fig. 4.1 Final enhanced X-ray pistol image (a) Original Image (b) H.E Result (c) H.S Result (d) Proposed Result

V. CONCLUSION

We used the FIA Airport luggage Image that is contaminate with three different types of noise (Impulse, Poisson and Speckle) in original image with 50% noise density. De-noised all noisy images by all techniques and conclude from the results that:

The performance of the proposed technique is best for all kind of noise contaminated images.

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Author	Year	Operating Domain	Model	Processing techniques	Application
Agaian SS[7]	2007	Spatial domain	HE based Logarithmic transform LTHS	Log reduction zonal magnitude technique; Logarithmic transform histogram shifting	Traffic monitoring; Security Surveillance
Hao Hu[8]	2010	Spatial domain	Content adaptive video processing model	Content classification and adaptive processing	Computer vision
Tarik Arici[9]	2009	Spatial domain	HE based modification	Histogram modification framework, content adaptive algorithm	LCD display device; Low quality video
Sangkeun Lee[10]	2007	Spatial domain	Dynamic range compression	Discrete Cosine transform(DCT); Retinex theory	Image/video compressing
Viet Anhnguyen[11]	2009	Spatial domain Transform domain	Cauchy distribution model; AC transform coefficient	Video reconstructed from multiple compressed copies of video content	Compression video
R.C. Gonzalez[12]	2008	Spatial domain	HE	Global Histogram Equalization	Image/ Video Security Surveillance
Xuan Dong[13]	2010	Spatial domain	Image Inverting Model	Inverting the input low lighting video; dehaze algorithm	Traffic monitoring; Medical imaging
Shan Du[14]	2010	Spatial domain	ARHE model	Adaptive Region based Method	Face Recognition
A.A Wadud M[15]	2007	Spatial domain	Dynamic Histogram equalization	Dynamic Histogram Equalization technique	Medical Image, Low quality video
Boudraa A.O[16]	2008	Spatial domain	2DTKEO model	2D Teager- Kaiser Energy Operator	Medical image; Satellite image
David Menotti[17]	2007	Spatial domain	MHE model	Multi histogram equalization methods	Image processing
Sara Hashem[18]	2010	Spatial domain	Improve HE	Genetic algorithms	Compute high dynamic range image processing
George D[19]	2009	Spatial domain	Improve HS and HE	Histogram based image enhancement	Image processing

Table 1. A Brief Survey of Histogram Enhancement Techniques