Medical Image Enhancement Application Using Histogram Equalization in Computational Libraries

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Abstract– **Medical images are one of the fundamental images, because they are used in more sensitive field which is a medical field. The main goal of this paper is to give a simple guideline to build small application in order to enhance the Medical images using histogram equalization technique in MATLAB, which is the strong and most popular program in Computational Libraries, and the histogram equalization implemented without using the function histeq( ).**

Index Terms– **Computational Libraries, Contrast, Histogram Equalization, Image Processing and Medical Image Enhancement**

I. INTRODUCTION

THE term Digital Image Processing generally refers to the processing of a two-dimensional picture by a digital computer i.e., altering an existing image in the desired manner. For example, this processing may remove noise, improve the contrast of the image, remove blurring caused by movement of the camera during image acquisition, it may correct for geometrical distortions caused by the lens. Before going for image processing image enhancement is necessary. We will not be considering every image processing and enhancement technique in this section but we will see the enhancement of image through image histogram or better way histogram equalization. If an image is low contrast and dark, we wish to improve its contrast and brightness. The histogram equalization improve all parts of the image when the original image is irregularly illuminated. The enhancement techniques are employed in order to increase the contrast of an image. Therefore, the distinction of features in the scene canbe easily performed by visualization. This will augment the efficiency of image classification and interpretation.

Generally, an image can be enhanced by spreading out the range of scene illumination. This procedure is called contrast stretch. If the ranges of gray values are uniformly prolonged, the process will be called linear contrast stretch. The disadvantage of the linear contrast stretch is that a number of gray levels are equally assigned to the unusually appeared gray levels as to the often appeared gray levels. This effect still causes the ambiguous distinction of the similar features.To overcome the mention defect, the process of histogram equalization is applied. The process tries to assigned more number of gray levels to the frequency appeared gray levels.The enhanced image obtained from the global area histogram equalization will cause an effect of intensity saturation in darkness area and whiteness areas. The color image enhancement will be obtained by encoding the color of red, green and blue to three different spectral images.

II. IMAGE PROCESSING TECHNIQUE

Digital image processing techniques are typically classified into three categories. These categories include

- Image generation
- Enhancement
- Restoration.

Image generation is one of the digital image processing techniques that involves converting an image into some sort of ordered layout. For example, a scanner may pick up an image by creating a reflection. Digitization takes that reflection and attempts to arrange it into a series of pixels. Some forms of digitization make this arrangement by looking for variations in the amount of light recorded from the original image. So generation techniques help project and recognize a scanned image

Enhancement is a broad category of digital image processing techniques that manipulate a digitized image. Computer programs may allow users to duplicate and change scanned images. For example, a color photograph can be converted to black and white. Likewise, parts of an image can be sliced and transposed into another. So the process of enhancing an image involves improving contrast, brightness and hue.

Restoration is also one of the Digital image processing techniques. Some scanned images may pick up tears or lines. Noise, which may show up as random dots or streaks, can be eliminated through replacement techniques. Replicas of the average recorded scan line replace defective or missing pixels. Restoration may also involve the use of digital filtering. This

is one of the digital image processing techniques that are used to eliminate dots or image spots. Any pixel that falls outside of an average range of values is typically eliminated when filtering is used. Pixels that fall outside the average range will usually show up as dark or lighter spots on the image. So Restoration techniques help eliminate and correct errors that do not accurately reflect the original picture.

III. IMAGE ENHANCEMENT TECHNIQUE

In image enhancement, the goal is to accentuate certain image features for subsequent analysis or for image display. Medical images typically suffer from one or more of the following imperfections:

- low resolution (in the spatial and spectral domains)
- high level of noise
- low contrast
- geometric deformations
- presence of imaging artifacts

These imperfections can be inherent to the imaging modality (e.g., X-rays offer low contrast for soft tissues, ultrasound produces very noisy images, and metallicimplants will cause imaging artifacts in MRI) or the result of a deliberate trade-off during acquisition. For example, finer spatial sampling may be obtained through a longer acquisition time. However that would also increase the probability of patient movement and thus blurring. In this paper, we will only be interested in the processing and analysis of images and we will not be concerned with the challenging problem of designing optimal procedures for their acquisition.

IV. HISTOGRAM

The histogram of an image is a plot of the gray _levels values versus the number of pixels at that value.

A histogram appears as a graph with "brightness" on the horizontalaxis from 0 to 255 (for an 8-bit) intensity scale) and "number of pixels "onthe vertical axis. For each colored image three histogram are computed, one for each component (RGB, HSL).The histogram gives us a convenient –easy-to - read representation of the concentration of pixels versus brightness of animage, using this graph we able to see immediately:

1. Whether an image is basically dark or light and high or low contrast.

2. Give us our first clues about what contrast enhancement would be appropriately applied to make the image more subjectively pleasing to an observer, or easier to interpret by succeeding image analysis operations.

So the shape of histogram provide us with information about nature of the image or sub image if we considering an object within the image. Forexample:

1. Very narrow histogram implies a low-contrast image

2. Histogram skewed to word the high end implies a brightimage

3. Histogram with two major peaks, called bimodal, implies an object that is in contrast with the background

examples of the different types of histograms are shown in following Fig. 1 to Fig. 6.
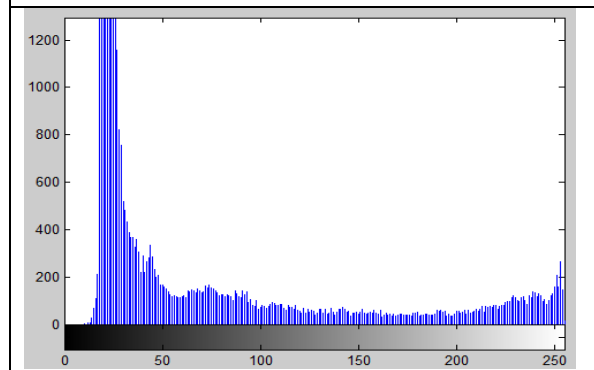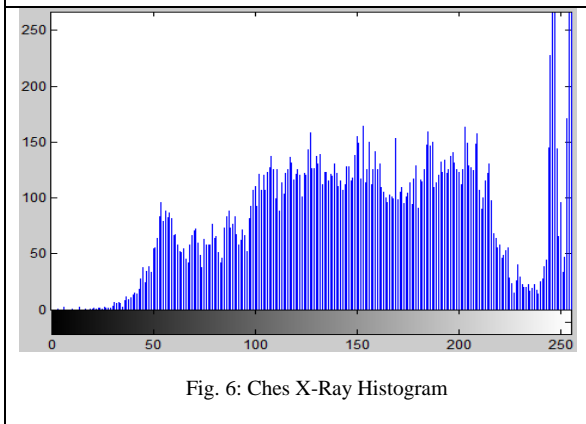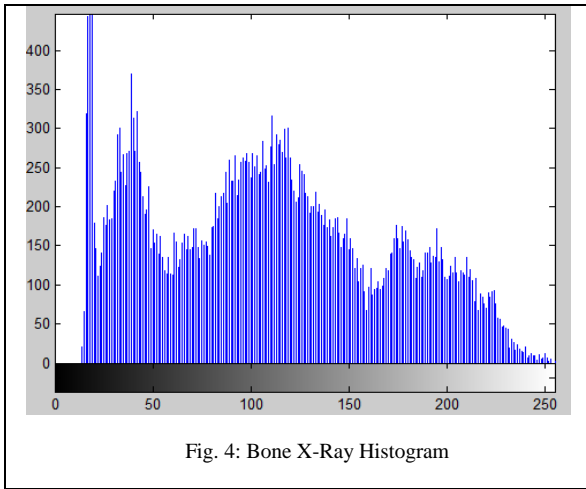

Fig. 1: Hand X-Ray

Fig. 2: Hand X-Ray Histogram

Fig. 3: Bone X-Ray

Fig. 4: Bone X-Ray Histogram

Fig. 5: Ches X-Ray

Fig. 6: Ches X-Ray Histogram

V. HISTOGRAM EQUALIZATION

Histogram equalization is a popular technique for improving the appearance of a poor image. It's similar to that of a histogram stretch but often provides more visually pleasing results across a wide range of images. Histogram equalization is a technique where the histogram of the resultant image is as flat as possible (with histogram stretching the overall shape of the histogram remains the same).

The results in a histogram with a mountain grouped closely together to "spreading or flatting histogram makes the dark pixels appear darker and the light pixels appear lighter.

The histogram equalization algorithm tries to assign the ideal number of pixels i to each grey value, to compute the correct new grey values, the algorithm makes use of the cumulative histogram: if $h(x)$ is a histogram, the cumulative histogram $c(x)$ is defined by:

$$c(x) = \int_{-\infty}^{x} h(y)dy \qquad (1)$$

For digital images with an integer grey value range this boils down to:

$$c(x) = \sum_{y \leq x} h(y) \qquad (2)$$

VI. ALGORITHM: HISTOGRAM EQUALIZATION

Given an image with dimensions dx and dy, i.e., it has dx X dy pixels, with N possible grey values ordered as $\{0, \ldots, N-1\}$, and a cumulative histogram c(v):

1. Determine the ideal number of times each grey value should occur in the image:

$$i = \frac{d_x \times d_y}{N} \qquad (3)$$

2. Remap the grey values according to

$$g^*(v) = \left\lfloor \frac{c(v)}{i} + 0.5 \right\rfloor - 1 \qquad (4)$$

3. Remap the grey values according to

$$(5)$$

$$g(v) = \begin{cases} g^*(v) & if \quad g^*(v) \geq 0 \\ 0 & if \quad g^*(v) < 0 \end{cases}$$

VII. THE APPLICATION

In the application we use uigetfile function to displays a modal dialog box that lists image files in the current folder and enables you to select or enter the name of a file. If the file name is valid (and the file exists), uigetfile returns the file name as a string when you click *Open*. If you click *Cancel* (or the window's close box), *uigetfile* returns Error *msgbox*.
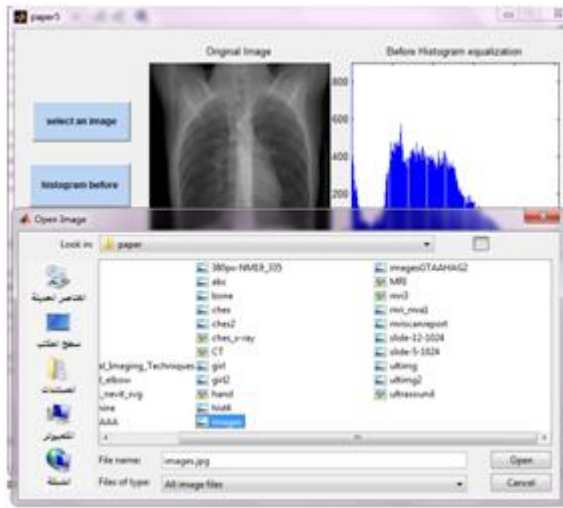
Fig. 7: Image file selection

When you select the image file correctly the image will open in the guide form, then you can get the histogram of the original image, the histogram after equalization, and the image after histogram equalization as shown in the results.

VIII. RESULTS

The proposed methods have applied on different medical images. Some results are illustrated below. In each figure we will see the origin image and it's Histogram, then the equalized histogram and it's new image. All this by clicking on the corresponding command button in the application form.
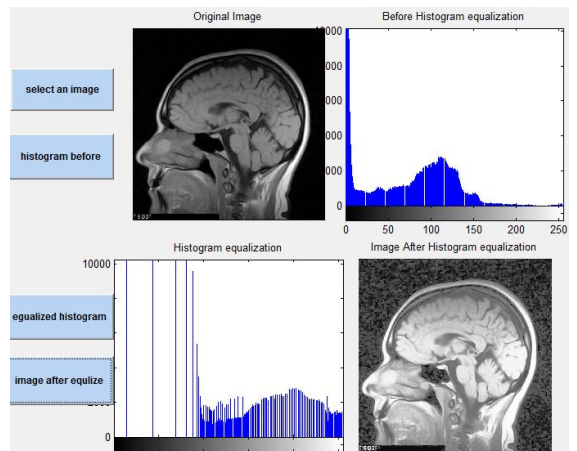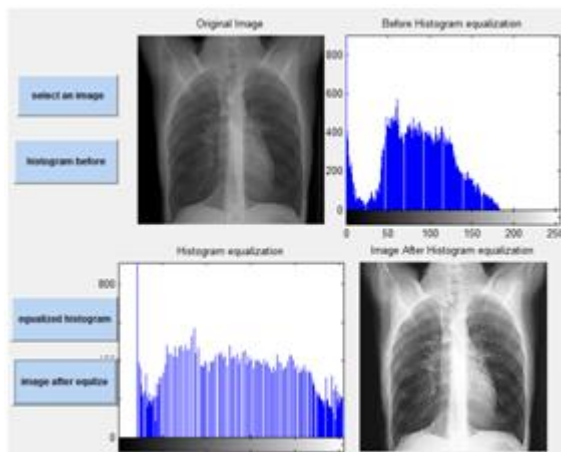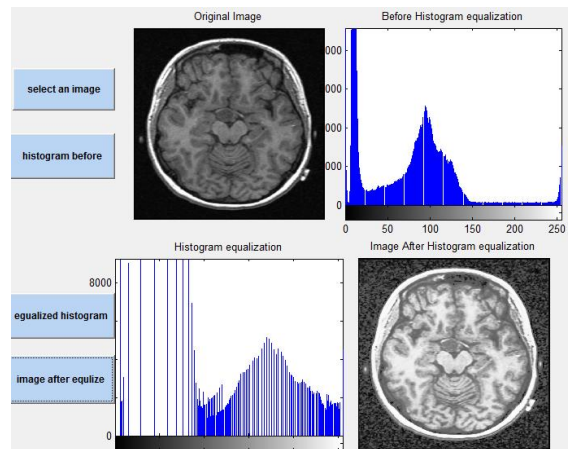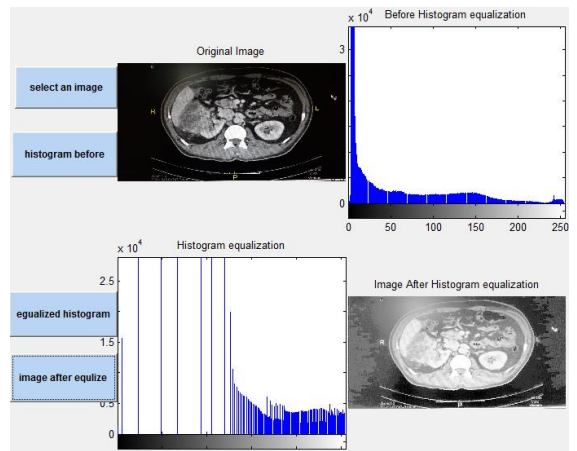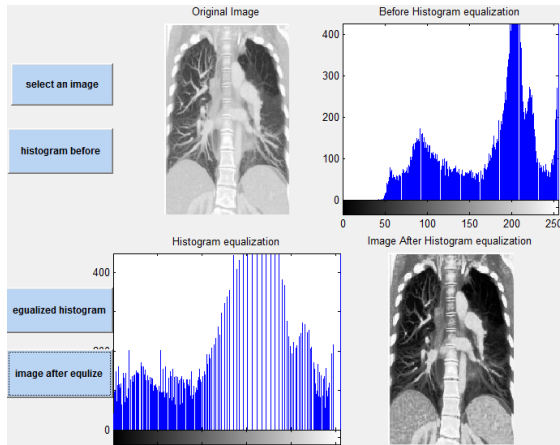
IX.   CONCLUSION

In the proposed method, we have built small application to enhance medical images by effective enhancement algorithm which is histogram equalization.

Histogram equalization is powerful method for image enhancement and it will increase the contrast of image. The enhanced image will give the full dynamic range of histogram.

However, histogram equalization process tries to merge the adjacent gray levels together in order to force the uniformity of number of pixels in each appeared gray levels.

The proposed methods have been implemented by the strongest and most popular program in Computational Libraries (MATLAB).

APPENDEX:

```matlab
function varargout = paper5(varargin)
gui_Singleton = 1;
gui_State = struct('gui_Name',       mfilename, ...
'gui_Singleton',  gui_Singleton, ...
'gui_OpeningFcn', @paper5_OpeningFcn, ...
'gui_OutputFcn',  @paper5_OutputFcn, ...
'gui_LayoutFcn',  [] , ...
'gui_Callback',   []);
if nargin&&ischar(varargin{1})
gui_State.gui_Callback = str2func(varargin{1});end
if nargout
    [varargout{1:nargout}]       =       gui_mainfcn(gui_State,
varargin{:});
else
gui_mainfcn(gui_State, varargin{:});end
function  paper5_OpeningFcn(hObject, eventdata, handles,
varargin)
handles.output = hObject;
guidata(hObject, handles);
function varargout = paper5_OutputFcn(hObject, eventdata,
handles)
varargout{1} = handles.output;
function pushbutton1_Callback(hObject, eventdata, handles)
function pushbutton2_Callback(hObject, eventdata, handles)
global im
axes(handles.axes2);
b=rgb2gray(im);
imhist(b);title('Before Histogram equalization');
function pushbutton3_Callback(hObject, eventdata, handles)
global im
GIm=im;
numofpixels=size(GIm,1)*size(GIm,2);
HIm=uint8(zeros(size(GIm,1),size(GIm,2)));
freq=zeros(256,1);
probf=zeros(256,1);
probc=zeros(256,1);
cum=zeros(256,1);
output=zeros(256,1);
for i=1:size(GIm,1)
for j=1:size(GIm,2)
    value=GIm(i,j);
    freq(value+1)=freq(value+1)+1;
probf(value+1)=freq(value+1)/numofpixels;end
end
sum=0;
no_bins=255;
for i=1:size(probf)
  sum=sum+freq(i);
  cum(i)=sum;
probc(i)=cum(i)/numofpixels;
  output(i)=round(probc(i)*no_bins);end
for i=1:size(GIm,1)
for j=1:size(GIm,2)
HIm(i,j)=output(GIm(i,j)+1);end
end
axes(handles.axes3);imhist(HIm);title('Histogram
equalization');
function pushbutton4_Callback(hObject, eventdata, handles)
global im
GIm=im;
numofpixels=size(GIm,1)*size(GIm,2);
HIm=uint8(zeros(size(GIm,1),size(GIm,2)));
freq=zeros(256,1);
probf=zeros(256,1);
probc=zeros(256,1);
cum=zeros(256,1);
output=zeros(256,1);
for i=1:size(GIm,1)
for j=1:size(GIm,2)
    value=GIm(i,j);
    freq(value+1)=freq(value+1)+1;
probf(value+1)=freq(value+1)/numofpixels;end
end
sum=0;
no_bins=255;
for i=1:size(probf)
  sum=sum+freq(i);
  cum(i)=sum;
probc(i)=cum(i)/numofpixels;
  output(i)=round(probc(i)*no_bins);end
for i=1:size(GIm,1)
for j=1:size(GIm,2)
HIm(i,j)=output(GIm(i,j)+1);end
end
```

```
GIm=rgb2gray(GIm);
axes(handles.axes4);imshow(HIm);title('Image          After
Histogram equalization');
function pushbutton5_Callback(hObject, eventdata, handles)
globalim im2
[path, user_cance]=imgetfile();
ifuser_cance
msgbox(sprintf('Error'),'Error','Error');
return
end
im=imread(path);
im2=im;
axes(handles.axes1);
imshow(im);title('Original Image');
```

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