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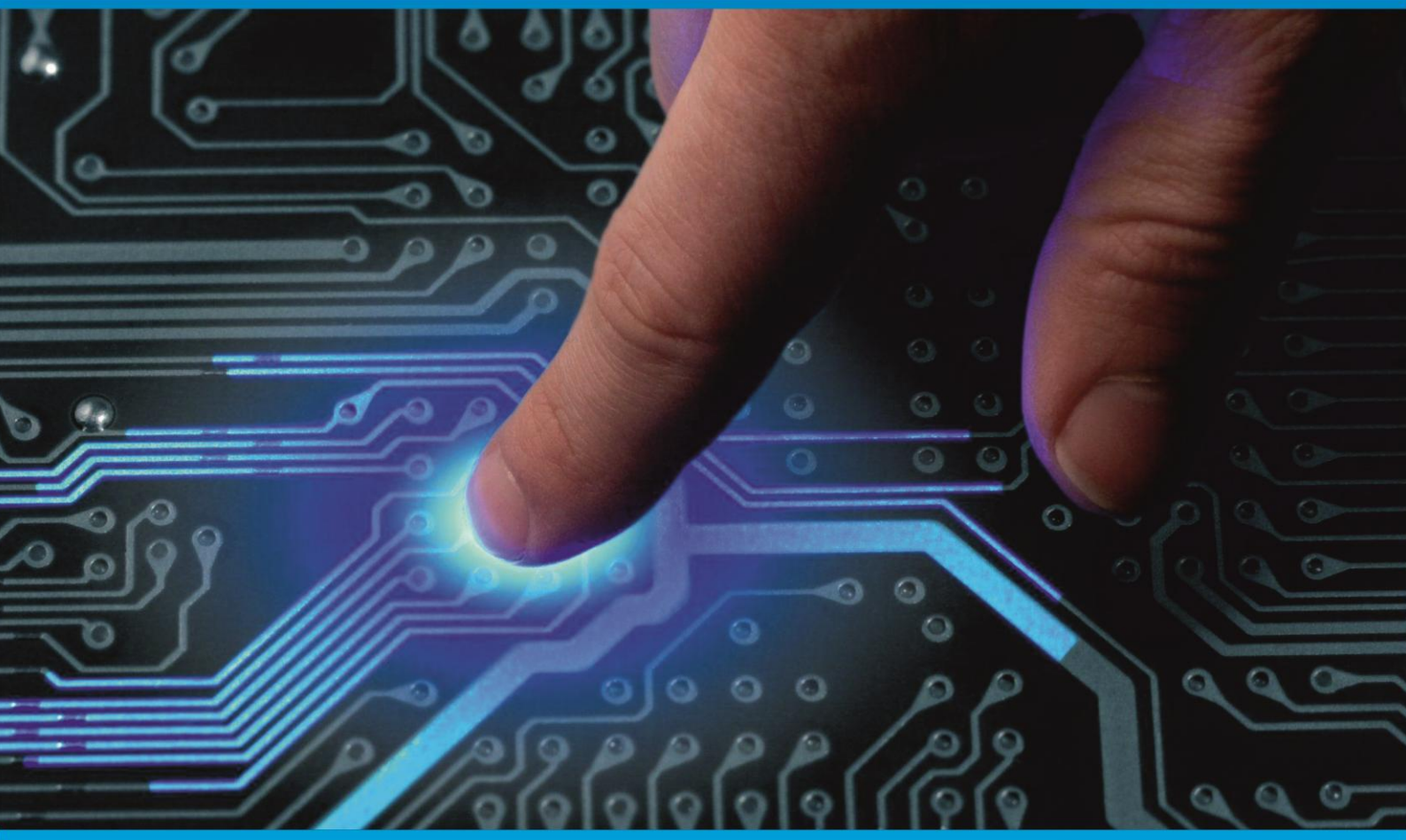

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Simple and Effective Method (SEM) for Image Contrast Enhancement

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ABSTRACT: Digital image histogram equalization is an effective method for image contrast enhancement as it can automatically define the gray-levels transformation function based on the distribution of gray-levels included in the image. Histogram equalization fails to produce satisfactory results for a broad variety of low-contrast images because it does not use a spatial feature included in the input image. The proposed SEM shows better enhancement results compared to the histogram results for both gray and color images.

In this research paper, we introduce SEM for gray and color images. SEM will use two parameters low-limit and up-limit to calculate the new intensity values of the new pixels to form an enhanced image, the proposed calculations are very simple and easy to implement. Some experiments will be performed varying the values of SEM parameters; the obtained results will be compared with histogram equalization results. It will be shown how SEM parameters affect the mean values of the image, and how they affect the image contrast.

KEYWORDS: Histogram equalization, SEM, low-limit, up-limit, V-min, V-max, histogram.

I.INTRODUCTION

Digital images [40], [41, [42] are one of the most important types of data and one of the most widely used and widely circulated ones[43], [44], as they are used in many vital and important applications for humans[45], [46], [47], [48]. The process of using the digital image in any application requires a preliminary treatment that consists in improving the image and making it visible to the naked eye [52], [53]. Therefore, image contrast enhancement is one of the basic requirements in digital image processing [49], [50], [51].

Many applications [33] deal with two main types of images [34-39]: greyscale images and color images. Digital grayscale image is a set of pixels arranged in 2D matrix, while digital color image is a set of pixels arrange in 3D matrix (one dimension for each color: Red, green and blue).

Any gray image can be represented by a histogram [1], [2], [3], which shows the repetition of each intensity value in the image (as shown in figure 1), this histogram can be equalized to enhance the image contrast by effectively spreading out the most frequent intensity values [4], [5], [6].

The histogram of the color image consists of three array histogram[7], [8], [9](one array for each color), each color must be extracted and treated alone using histogram equalization (HE)[10], [11], [12], then the equalized colors must be gathered to form the equalized color image [13], [14] as shown in figures 2 and 3.

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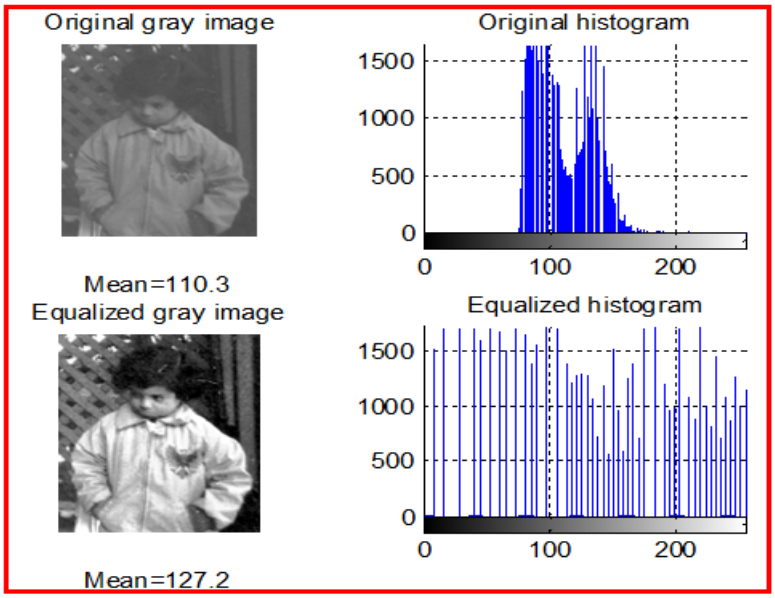

Figure 1: Gray image equalization

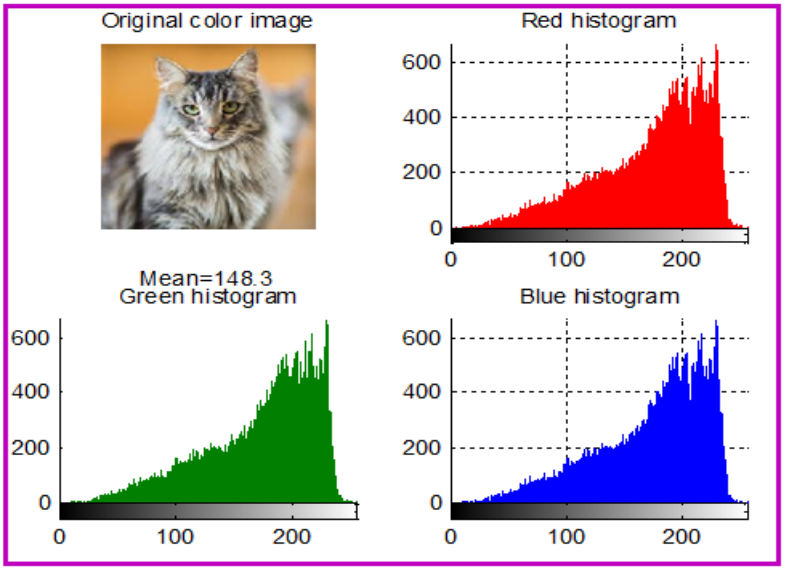

Figure 2: Color image and histograms

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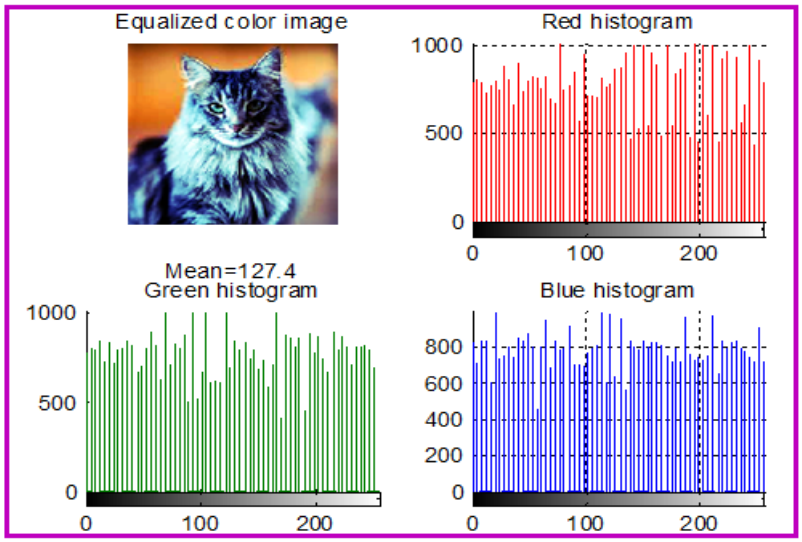

Figure 3: Equalized color image and histograms

HE will work the best when applied to images with much higher color depth than palette size, like continuous data or 16-bit gray-scale images [15], [16]. There are two ways to think about and implement histogram equalization, either as image change or as palette change. Image enhancement can be done by histogram equalization [17], [18], [19]. HE is a technique for adjusting image intensities to enhance contrast. Through this adjustment, the intensity values of the image pixel can be better distributed on the histogram [20-32], allowing areas of lower local contrast to gain a higher contrast. HE some times will give an improvement in the image histogram by enhancing the image contrast as shown in figure 2, but some time it will add a negative effects decreasing the image contrast as shown in figure 3.

II.PROPOSED SEM TO ENHANCE THE IMAGE CONTRAST

The proposed SEM method of image enhancement is based on selecting two parameters, the lower limimt and the upper limit(each summmation must be equal 1), and by selecting a propar values of these parameters we can achieve the required image enhancement, and it can be used for gray and color images.
SEM method can be implemented applying the following steps:

- ✓ DEFINE THE VALUES OF THE LIMITS.
- ✓ RESHAPE THE IMAGE INTO ONE COLUMN.
- ✓ SORT THE ARRAY COLUMN.
- ✓ CALCULATE V_MAX AND V_MIN AS SHOWN IN FIGURES 4 AND 5.
- ✓ USE V_MAX AND V_MIN TO CALCULATE THE NEW ENHANCED IMAGE.
- ✓ CONVERT THE OBTAINTD IMAGE TO UINT8 IMAGE.

Figures 4 and 5 illustraite and examples of SEM implementation, and from these example we can see the following facts:

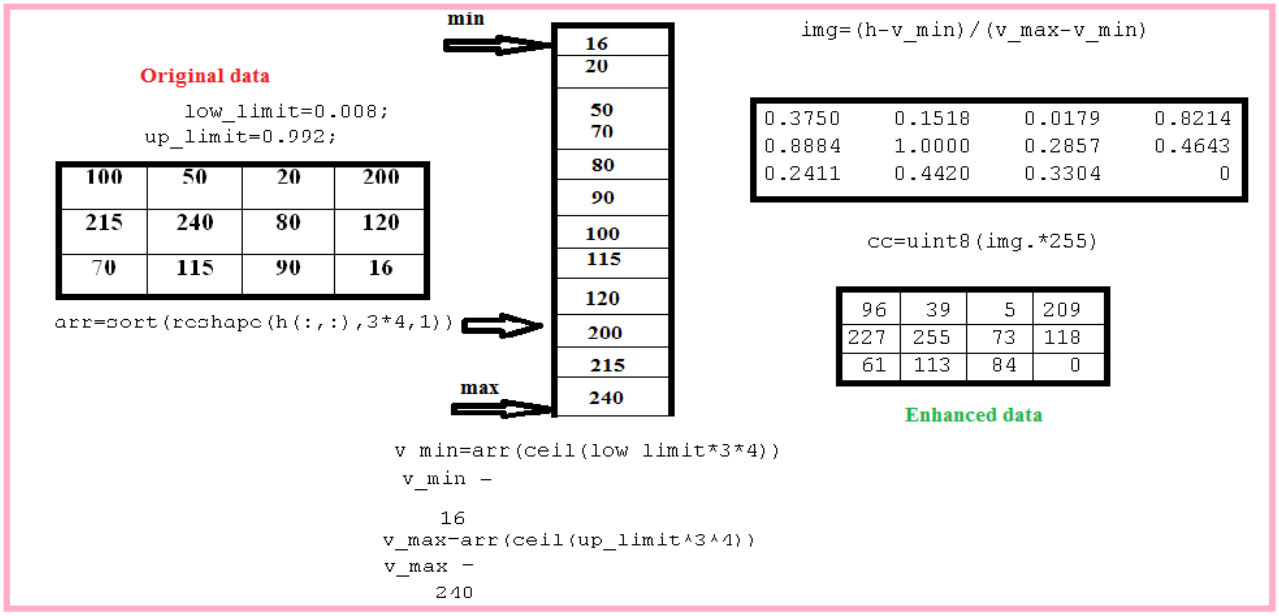

Figure 4: SEM example 1

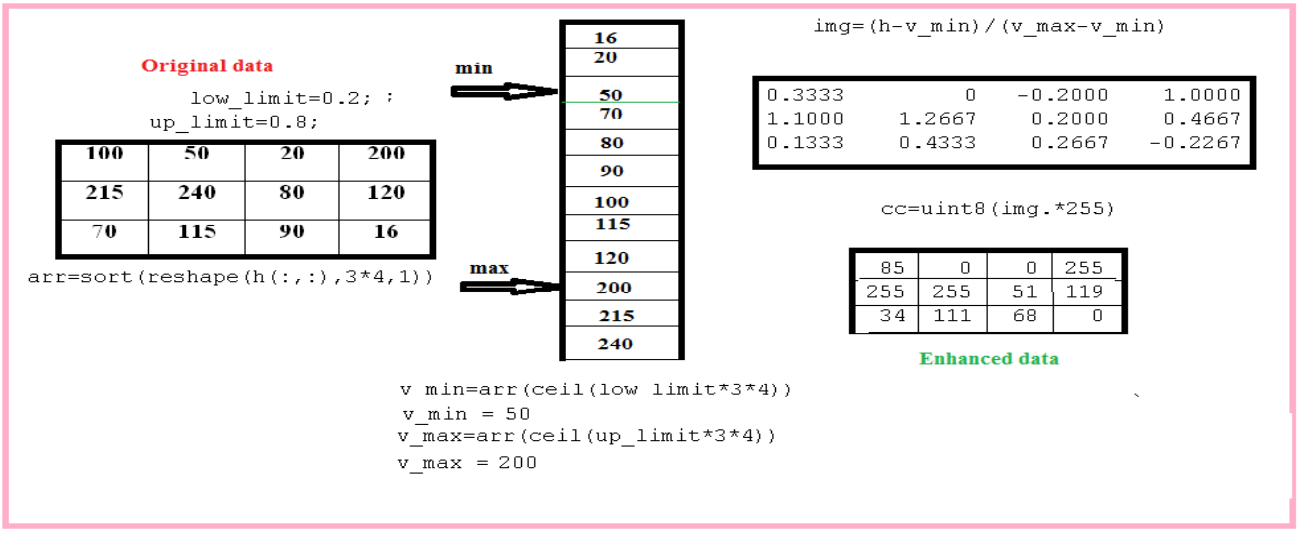

Figure 5: SEM example 2

- THE SELECTED VALUES OF THE LIMITS WILL CAUSE VARIOUS CHANGES ON THE OUTPUT IMAGE.
- SELECTING A VERY SMALL VALUE TO THE LOW_LIMIT AND HIGH VALUE TO UP_LIMIT WILL ADD SMALL VALUES TO HIGH PIXEL INTENSITIES AND SUBTRACT SMALL VALUES FROM LOW INTENSITIES PIXELS (SEE FIGURE 4).
- SELECTING A VERY A BIGGER VALUE FOR THE LOW_LIMIT WILL CAUSE HIGHER INTENSITIES FOR SUBTRACTION (SEE FIGURE 4).
- MOSTLY SEM METHOD WILL DECREASE THE PIXELS AVERAGE INTENSITIES.
- SEM CAN BE IMPLEMENTED SEVERAL TIMES TO ADD EXTRA ENHANCEMENT TO THE IMAGE.

III.IMPLEMENTATION AND EXPERIMENTAL RESULTS

The proposed SEM method was implemented using matlab, below is the code which was used:

```
%Defining SEM parameters
low_limit=0.002;
up_limit=0.998;

img=imread('pout.tif'); [m1 n1 r1]=size(img);img=double(img);
%--------------------calculation of v_min and v_max----------------------
for k=1:r1
    arr=sort(reshape(img(:,:,k),m1*n1,1));
    v_min(k)=arr(ceil(low_limit*m1*n1)) ;
    v_max(k)=arr(ceil(up_limit*m1*n1));
end
%-------------------------------------------------------------------------
if r1==3
    v_min=rgb2ntsc(v_min) ;
    v_max=rgb2ntsc(v_max) ;
end;
%-------------------------------------------------------------------------
img=(img-v_min(1))/(v_max(1)-v_min(1));
imwrite(uint8(img.*255),'out1.tif');
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
cc=uint8(img.*255);figure
imshow(cc)
```

Calculating V_max and V_min

If the image is color

Getting the output image

A gray image shown in figure 6 was taken and enhanced using HE and SEM, the obtained output images shows that the contrast of SEM method is better than the obtained image using HE.

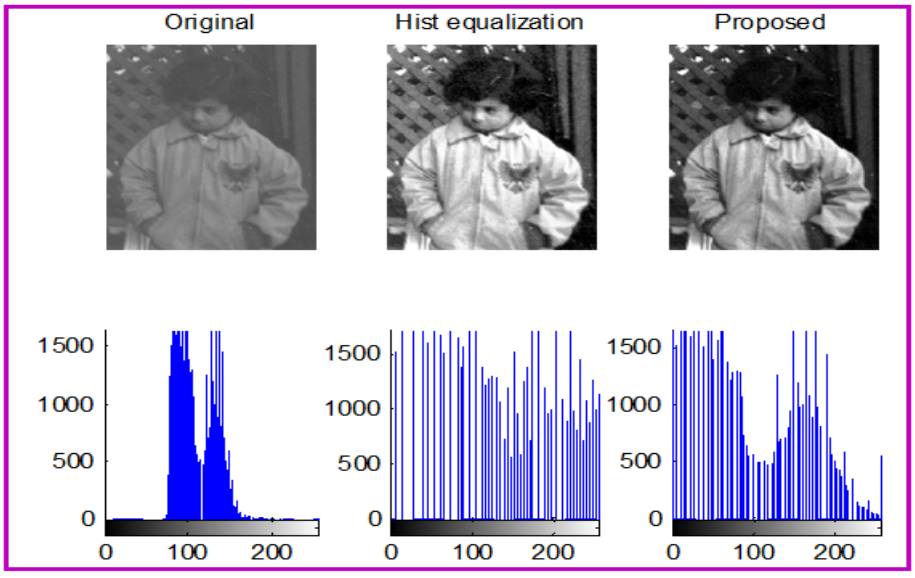

Figure 6: Enhancing gray image

Another color image which is shown in figure 7 was taken and enhanced using HE and SEM, figure 8 and 9 show the obtained output images.

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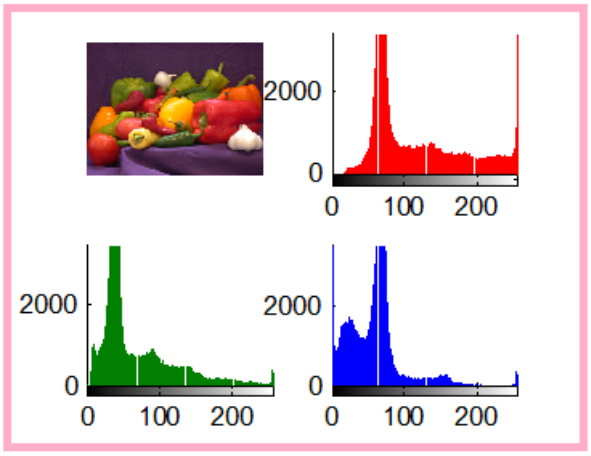

Figure 7: Color image example

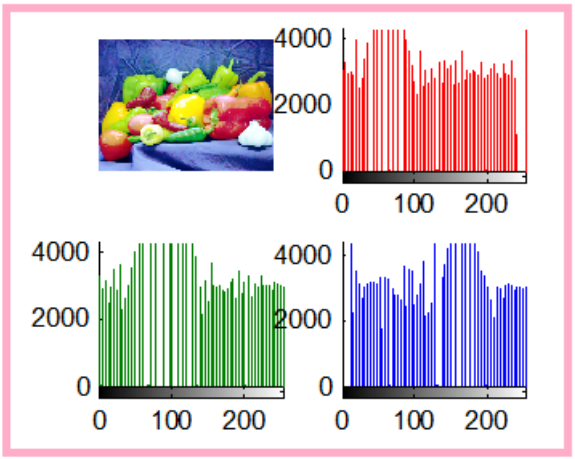

Figure 8: Obtained image after applying HE.

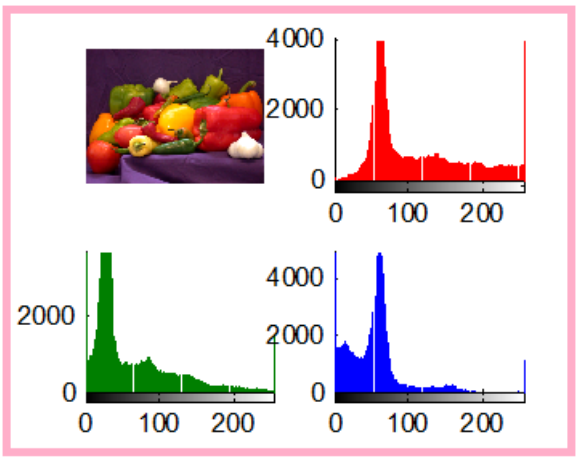

Figure 9: Obtained image after applying SEM.

From figures 8 and 9 we can see that HE fails to enhance the image, while SEM adds an improvement to the image by icreasing the image contrast.

SEM was also implemented using various images and various values of SEM parameters and it was seen that SEM provides a good distribution of the pixel intemsities, making a good enhancement to the image. The obtained experimental results showed the following facts:

- SEM can be easily used to enhance gray and color images.
- Good selection of SEM parameters will cause a better enhancement in the output image.

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- HE some times increases the pixel intensities average, and some time it decreases the average, which mean that for some images it is good to use HE and for other times HE does not add an enhancement (see figure 8).
- SEM always decreases the pixel intesities average.
- SEM limits affect the inteinsiteis were to start decreasing the pixel values, and where to start increasing higher intesities, thus we can control the process of enhancement.
- SEM can be repeated several times to achieve the best enhancemment.

IV.CONCLUSION

A simple and effective SEM method was proposed, tested and implemented. The otained experimental results showed that SEM method provides better image enhancement comparing with HE method of enhancement. It was show that some time HE method fails tp achieve the required enhancement, while for other times HE sucseese to do the enhancement. SEM method can be applied using any type of images, and it always enhance the image by controling the limits of the SEM method.

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