transfer functions for various applications, like contrast enhancement and shadow enhancement and provides a flexible and efficient way for image enhancement. Hojat Yeganeh [6] presents a novel approach for contrast enhancement based on histogram equalization (HE) and applies some preprocessing steps on the histogram corresponding to the image and then applies histogram equalization. He applied the proposed algorithm on a database which includes 220 normal images and results are promising. The proposed method has better results comparing with Bi Histogram Equalization (BHE) algorithm based on visual criterion and a mathematical criterion. Qian Wang [16] proposed a novel histogram mapping method i.e local-mean based strict pixel ordering method to overcome the problem that the histogram equalization can fail for discrete images. He uses a fast local feature generation technique to establish a combined histogram that represents voxels' local means as well as grey levels. Different sections of the combined histogram, separated by individual peaks, are independently mapped into the target histogram scale under the constraint that the final overall histogram should be as uniform as possible. By using this method, the speed of histogram equalization is dramatically improved, and the satisfactory enhancement results are also achieved. Takashi Kawakami [14] proposed a novel Histogram Equalization (HE) called mean preserving bi-histogram equalization (BBHE) method with variable enhancement and separation intensity degree to avoid the saturation effect. Finally, these two proposed methods are combined and control the enhancement degree by two parameters. Debashis Sen [3] introduced an automatic exact histogram specification technique which aims at information maximization and used it for global and local contrast enhancement of images. The desired histogram is obtained by first subjecting the image histogram to a modification process and then by maximizing a measure that represents increase in information and decrease in enhancing contrasts of grayscale images as demonstrated through visual assessment of results. Gabriel Thomas [4] proposes a new technique for specifying a histogram to enhance the image contrast and use them on segmentation approaches also. He emphasizes the flexibility of this image processing approach to do more than enhancing images. Dah-Chung Chang [2] presents a new ACE (adaptive contrast enhancement) algorithm, which uses contrast gains (CG's) to adjust the high frequency components of images and eliminates uses noise over enhancement and ringing artifacts in conventional approaches. Yu Wang [17] proposed a novel histogram equalization technique, equal area dualistic sub-image histogram equalization. First, the image is decomposed into two equal area sub-images based on its original probability density function. Then, the two sub-images are equalized respectively. At last, the results after the processed sub-images are composed into one image. The simulation result indicates that the algorithm can not only enhance image information effectively but also keep the original image luminance well enough to make it possible to be used in video system directly. P. Rajavel [12] proposes image-dependent brightness preserving histogram equalization (IDBPHE) technique to enhance image contrast while preserving image brightness. The curvelet transform and histogram matching technique are used to enhance image. The proposed IDBPHE technique undergoes two steps. (i) The curvelet transform is used to identify bright regions of the original image. (ii) Histogram of the original image is modified with respect to a histogram of the identified regions. It enhances image contrast while preserving image brightness without any undesired artifacts. Md. Foisal [10] presents a new method of image enhancement that improves the visual quality of digital images as well as image that exhibits dark shadows due to limited dynamic range of imaging. In this paper non linear image enhancement technique is used in transform domain by the way of transform coefficient histogram matching to enhance image. Processing includes global dynamic range correction and local contrast enhancement which is able to enhance the luminance in the dark shadows keeping the overall tonality consistent with that of the input image. Logarithmic transform histogram matching is used which uses the fact that the relation between stimulus and perception is logarithmic. Komal Vij [8] reviews and summarizes some Histogram Processing Techniques for Image enhancement. Numerous enhancement methods have been proposed but the enhancement efficiency, computational requirements, noise amplification, user intervention, and application suitability are the common factors to be considered when choosing from these different methods for specific image processing application. Rajesh Garg [13] proposes various enhancement schemes used for enhancing an image which includes gray scale manipulation, filtering and Histogram Equalization (HE). The basic idea of HE method is to re-map the gray levels of an image. HE tends to introduce some annoying artifacts and unnatural enhancement. To overcome these drawbacks different brightness preserving techniques are used which and their Comparative analysis is done on the basis of subjective and objective parameters, Peak signal to-noise ratio (PSNR), Mean squared error (MSE), Normalized Absolute Error (NAE), Normalized Correlation, Error Color and Composite Peak Signal to Noise Ratio (CPSNR). Pavithra P [11] extends the classical histogram specification technique

3.3 Histogram Specification

It is also called *Histogram Matching*. The histogram equalization (HE) is not suitable for iterative image manipulation. If we want to enhance only certain region of the histogram then, we will use histogram specification. We have the input image, then the target histogram is specified, we have to process the image in such a way that the histogram of the processed image will be close to the target image. From given image, we have

$$p_r(r_k) = \frac{n_k}{n} \qquad (12)$$

The target histogram which is given by $p_z(z_k)$. But we do not have any image correspond to target histogram. From equation (12), we get

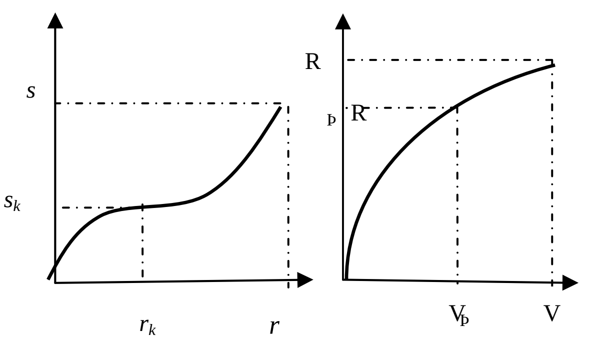
$$s_k = T(r_k) = \sum_{j=0}^{k} \frac{n_j}{n} = \sum_{j=0}^{k} p_r(r_j) \qquad (13)$$

$$v_k = G(z_k) = \sum_{i=0}^{k} p_z(z_i) = s_k \qquad (14)$$

$$z_k = G^{-1}(s_k) \qquad (15)$$

We can find out G^{-1} by using Iterative procedure as follows:

1. Obtain histogram of the given image.
2. Precompute a mapped level s_k from each level r_k
   $$s_k = \sum_{j=0}^{k} \frac{n_j}{n} \qquad (17)$$
3. Obtain transformation function G from given
   $$v_k = G(z_k) = \sum_{i=0}^{k} p_z(z_i) = s_k \qquad (18)$$
4. Precompute z_k for each level of s_k using iterative scheme.
   For each pixel in the original image, if the value of the pixel is r_k, map this to its corresponding level s_k, then map s_k into the final level z_k using precomputed values.
   So, histogram specification gives the mapping from *r* to z.



a)Forward Transformation b) Inverse Transformation
Figure 3.

We have to find out,

$$s_k \to r_k \to z_k \to v_k$$

But the problem is that z_k is unknown. So, this will find out with the help of G^{-1}.

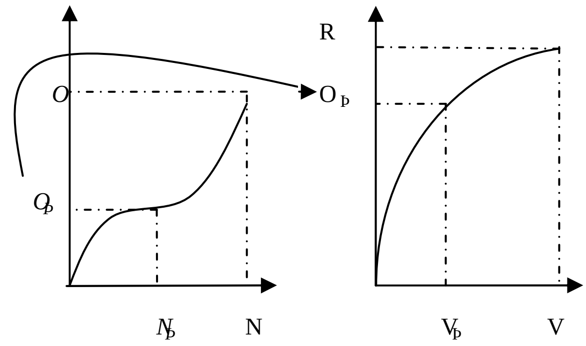


Figure 4. Iterative procedure to find out z_k from s_k

We know r_k, we can easily find s_k from r_k by using $s = T(r)$. After that we will set $v_k = s_k$ and thus find out z_k from this s_k or v_k. Sometimes, analytically, it is not possible to find this. But in discrete domain, both these transformation function $s = T(r)$ and $v = G(z)$ can be implemented in the form of arrays.

$$v_k = G(z_k) = s_k \qquad (19)$$

$$G(z_k) - s_k = 0$$

We assume z_k is nearly equal to $\hat{z}$, It should satisfy

$$G(\hat{z}) - s_k \geq 0$$

So, we will increment value of $\hat{z}$ by 1 iteratively unless that condition met. For example, suppose r and z varies from 0 to 7. i.e.

r = 0, 1, 2, …………..7 and

z = 0, 1, 2……………....7.

The value of $p_r(r)$ is given. The probability when intensity value is 0, $p_r(0) = 0$.

Similarly,

$p_r(1) = p_r(2) = 0.1$; $p_r(3) = 0.3$, $p_r(4) = p_r(5) = 0.1$, $p_r(6) = 0.4$, $p_r(7) = 0.1$.

The value of Target Histogram, $p_z(z)$ will be

$p_z(0) = 1$, $p_z(1) = 0.1$, $p_z(2) = 0.2$, $p_z(3) = 0.4$, $p_z(4) = 0.2$, $p_z(5) = 0.1$, $p_z(6) = p_z(7) = 0$

We have to find out mapping function from $r \to z$.

First, we have to map from $r \to s$ then $s \to z$. For that, we have the find out the minimum value of z. For that we have to find out the minimum value of z.

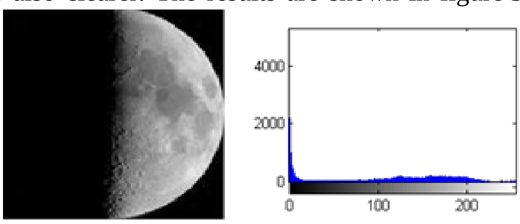
The mapping is showing in table 2.

Table 2.

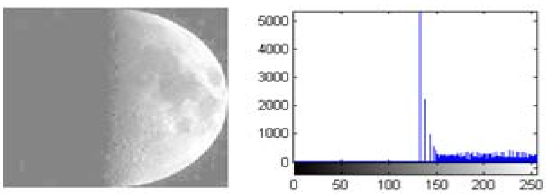
r	$p_r(r)$	$T(r) = \sum_{i=0}^{r} p_r(i) = s_k$	t'	t	$p_z(z)$	$G(z)$
0	0	0	0	0	0	0
1	0.1	0.1	1	1	0.1	0.1
2	0.1	0.2	2	2	0.2	0.3
3	0.3	0.5	3	3	0.4	0.7
4	0	0.5	3	4	0.2	0.9
5	0	0.5	3	5	0.1	1.0
6	0.4	0.9	4	6	0	1.0
7	0.1	1.0	5	7	0	1.0

4. Results and Discussions

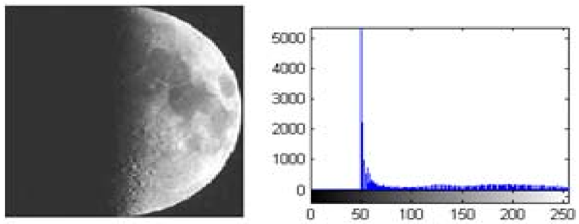
For darker image, the histogram will be spread on the left side while for brighter image, it will be on right side. Better the image better will be the histogram. For enhancement of poor contrast image, we can use the Histogram Equalization techniques. But in certain specific situation, the background is almost washed out. In such cases, we can use the Histogram Specification methods. In Histogram Specification, the target histogram which was specified was obtained using Histogram Equalization. On comparing two images, it is analyzed that in case of Histogram Specification the contrast of background is much more and details are also clearer. The results are shown in figure 5.



(a) Before histogram equalization



(b) After histogram equalization



(c) After histogram specification

Figure 5. Comparison between Histogram Equalization and Histogram Specification

5. Conclusion

In this paper, we analyze two image enhancement techniques based on spatial domain approach. In Histogram Equalization, we generates a gray map which changes the histogram of an image and redistributing all pixels values to be as close as possible to a user-specified desired histogram. Histogram equalization allows for areas of lower local contrast to gain a higher contrast. In Histogram Specification, we have the input image, then the target histogram is specified, we have to process the image in such a way that the histogram of the processed image will be close to the target image. The result shows that Histogram Specification is better than Histogram Equalization as it makes details and background in the image clearer, in some specific situation.

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