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# Review of Image Contrast Enhancement Techniques

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***ABSTRACT***-Contrast enhancement is one of the challenging issues in low level image processing. Contrast enhancement techniques are used for improving the visual perception and color reproduction of low contrast images. In this paper, various contrast enhancement techniques for low contrast images are reviewed. On behalf of that, histogram equalization, contrast stretching, recursive mean separate HE are some of the famous techniques that are used to improve the contrast of the input low contrast images. This paper concentrates the comparison between the various contrast enhancement techniques for low contrast images. The simulation results show that the proposed algorithms effectively enhance the contrast level of the low contrast input images. This paper also deliberates the process, merits and demerits of the various contrast enhancement techniques.

## 1. INTRODUCTION

Image enhancement is the simplest, most interesting and visually appealing areas of image processing. It can be used to improve the quality of certain features of an image. The aim of the image enhancement is to augment the interpretability or to provide better input for other automated image processing. Image enhancement techniques are broadly classified into two broad categories: spatial domain methods, which are based on the direct manipulation of pixels in an image. Frequency domain methods, which are based on modifying the fourier transform of an image. The visual results provide the visual interpretability of an image. The quantitative results are used to determine which techniques are most appropriate for processing.

Contrast enhancement is frequently referred to as one of the most important issues in image processing.Contrast enhancements improve the perceptibility of objects in the scene by enhancing the brightness difference between objects and their backgrounds. Contrast enhancements are typically performed as a contrast stretching process. The idea behind contrast stretching is to increase the dynamic range of gray levels in the image being processed. A contrast stretch improves the brightness differences uniformly across the dynamic range of the image, whereas tonal enhancements improve the brightness differences in the shadow (dark), mid-tone (grays), or highlight (bright) regions at the expense of the brightness differences in the other regions.

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**FIG 1: Difference between low contrast and high contrast of an image**

The above figure shows the difference between the low contrast and high contrast of the image. The left part of the image denotes the low contrast of the image. The right part of the image denotes the high contrast part of the image. While taking the left part for the analysis, there is no information is clear. Otherwise, if we take the right part, it provides clear information for the analysis.

As indicated previously, the term spatial domain refers to the combined of pixels composing an image. Spatial domain methods are procedures that operate directly on those pixels. Spatial domain processes will be denoted by the expression

$$g(x,y) = T[f(x,y)] \quad (1)$$

where f (x,y) is the input image , g (x,y) is the processed image, and T is an operation on f , defined over some neighborhood of (x,y). The principal approach involved in defining a neighborhood about a point (x,y) is to use a square or rectangular subimage are centererd at (x,y) as shown in the fig(2).

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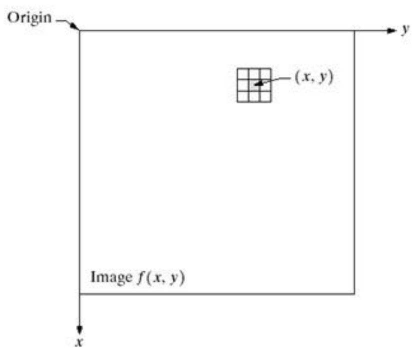


**FIG 2: A 3*3 neighborhood about a point (x,y) in an image.**

The center of the subimage is moved from pixel to pixel starting i.e., at the top left corner. The operator T is applied at each location (x,y) to yield the output , g, at that location . The process utilizes only the pixels in the area of the image spanned by the neighborhood. The simplest form of T is when the neighborhood is of size 1×1 (that is , a single pixel). In this case , g, depends only on the value of f at (x,y), and T becomes a gray –level (also called an intensity or mapping) transformation function of the form

$$s = T(r) \qquad (2)$$

Where r and s are variable denoting the gray levels of f ( x,y ) and g ( x,y ) at any point ( x,y ). For example , if T ( r ) has the form shown in the fig (3), the effect of this transformation would be to produce an image of higher contrast than the orginal by darkening the levels below m and brightening the levels above m in the orginal image.

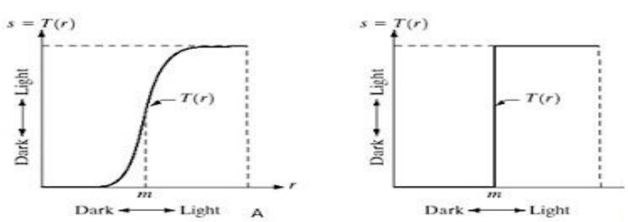


**FIG 3: Gray level transformation functions for contrast enhancement**

Image contrast enchanement techniques are used in photography satellite imagery, medical applicationsand display devices. In addition to producing visually natural is required for many important areas such as vision remote sensing dynamic scene analysis medical image processing, autonomous navigation speech recognition, and biomedical image analysis. As the rise in demand for high quality images, contrast enchancement techniques are required for better visual perception and colour reproduction. The contrast enhancement techniques can broadly classified into the following :

Gray level transformations:

- -Image negatives.
- -log transformations.
- -power-Law transformations.
- -piecewise-linear transformation functions.
  - -contrast stretching.
  - -Gray level slicing.
  - -Bit-plane slicing.
- -Histogram processing.

## 2.VARIOUS APPROACHES TO IMAGE CONTRAST ENHANCEMENT

Contrast enhancements improve the perceptibility of objects in the scene by enhancing the brightness difference between objects and their backgrounds. Contrast enhancements are typically performed as a contrast stretch followed by a tonal enhancement, although these could both be performed in one step. A contrast stretch improves the brightness differences uniformly across the dynamic range of the image.

### 2.1 Gray Level Transformation

Consider the figure 4, which shows the three basic types of functions used frequently for image enhancement; linear (negative and identity transformations), logarithmic ( log and inverse log transformations ) and power law ($n^{th}$ power and $n^{th}$ root transformation).

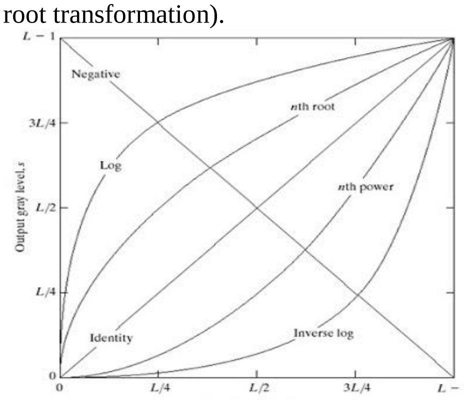


**FIG 4: Some basic gray level transformation functions**

#### 2.1.1 IMAGE NEGATIVES

The negative of an image with gray levels in the range, [0, L-1] is obtained by using the negative transformation shown in figure 4 , which is given by the expression

S = L-1-r ( 4)

Reversing the intensity levels of an image in this manner produces a equivalent of photographic negative. This type of processing is particularly suitable for enhancing white or gray detail embedded in dark regions of an image, especially when the black areas are dominant in size.

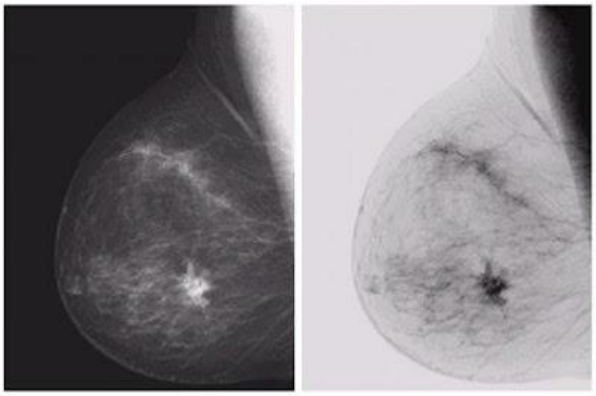

**FIG 5: Original and Negative mammogram**

### 2.1.2 LOG TRANSFORMATIONS

The general form of log transformation is shown in figure 4 and it is expressed using the equation given below;

$$s = c \log(1+r) \quad (5)$$

where is a constant, and it is assumed that r>=0. The shape of the log curve in figure (4) shows that this transformation maps a narrow range of low gray-level values in the input image into a wider range of output levels. The opposite is true of higher values of input levels.

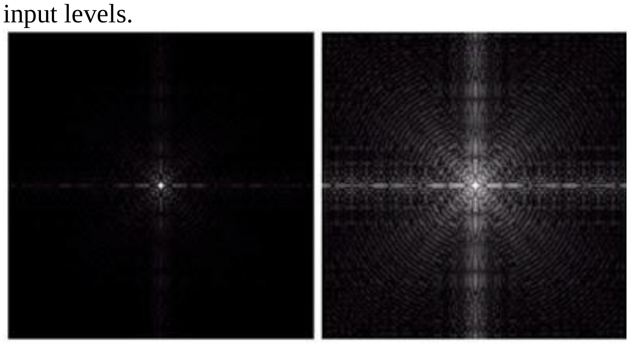

**FIG 6: Results of applying log transform (right) to the Fourier spectrum (left) when c=1**

### 2.1.3 POWER LAW TRANSFORMATION

The power law transformations have the basic form;

$$s = c\,\gamma^{r} \quad (6)$$

where c and $\gamma$ are positive constants. Sometimes this equation is written as $s = c\,(\gamma + e)^{r}$ to account for an offset. As in the case of log transformation, power law curves with fractional values of γ map narrow range of dark input values into a wider range of output values, with the opposite being true for higher values of input levels. Unlike the log function, a family of possible transformation curves obtained simply by varying γ as shown in figure (7). The curves generated with values of $\gamma>1$ have exactly the opposite effect as those generated with values of γ<1.

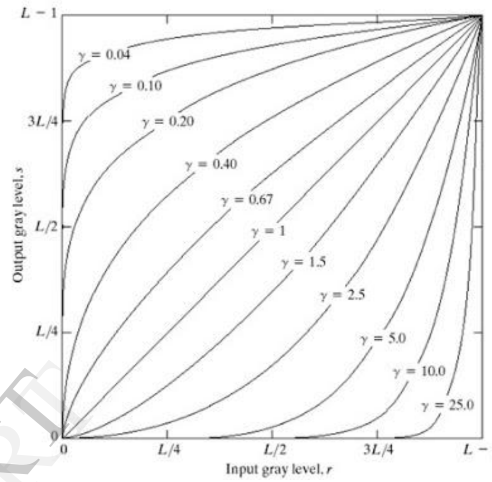


**FIG 7: Plots of the equation $s = c\,\gamma^{r}$ for various values of $\gamma$**

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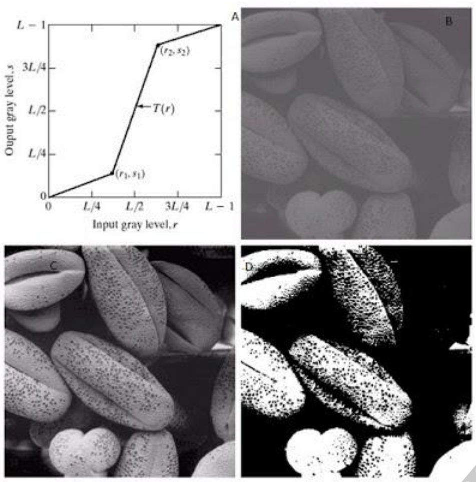
A variety of devices used for image capture, printing and image display respond according to the power law. By convention, the exponent in the power law equation is referred to as **gamma**. The process used to correct this power-law response phenomenon is called gamma correction. Gamma correction is important if displaying an image accurately on a computer screen of is concern. Images that are not corrected properly can look either bleached out, or what is more likely, too dark. Trying to reproduce colors accurately also requires some knowledge of gamma correction because varying the values of gamma correction changes not only brightness, but also the ratio of red to green to blue.

### 2.1.4 PIECE WISE LINEAR TRANSFORMATION FUNCTIONS

A complementary approach to the methods discussed in the previous three sections is to use piecewise linear functions. The principle advantage of the piece wise linear functions over the types of functions we have discussed thus far is that the form of piece wise functions can be arbitrary complex. The disadvantage of piece wise transformation is that their specification requires considerably more user input.

### 2.1.4.1 *CONTRAST STRETCHING*

Low contrast images can results from poor illumination, lack of dynamic range in the imaging sensor, or even wrong setting of a lens aperture during image acquisition. The idea behind contrast stretching is to increase the dynamic range of the gray levels in the image being processed. Figure (10) shows the contrast stretching and the location of points ($r_1$, $s_1$) and ($r_2$,$s_2$) control the shape of the transformation function




**FIG(10):Contrast stretching (A) form of transformation function (B) a low contrast image (C) result of contrast stretching (D) result of thresholding.**

If $r_1$=$s_1$ and $r_2$=$s_2$, the transformation is a linear function that produces no changes in gray levels. If $r_1$ = $r_2$, $s_1$=0 and $s_2$ = L-1, the transformation becomes a thresholding function that creates a binary image. Intermediate values of ($r_1$, $s_1$) and ($r_2$,$s_2$) produce various degrees of spread in the gray levels of the output image, thus affecting its contrast.

### 2.1.4.2 GRAY LEVEL SLICING

Normally, highlighting a specific range of gray levels in an image often is desired. One approach for gray level slicing is to display a high value for all gray levels in the range of interest and low value for all other gray levels. This produces a binary image. Another approach for gray level slicing is brightness the desired range of gray levels but preserves the background and gray level tonalities in the image.

### 2.1.4.3 BIT PLANE SLICING

Instead of highlighting gray level ranges, highlighting the contribution made to total image appearance by specific bits might be desired. Suppose that each pixel in an image is represented by 8 bits. Imaging that the image is composed of eight 1-bit planes, ranging from bit plane 0 for least significant bit to bit plane 7 for the most significant bit. In terms of 8-bit bytes, plane 0 contains all the lowest order bits in the bytes comprising the pixels in the image and plane 7 contains all the high order bits (figure10).

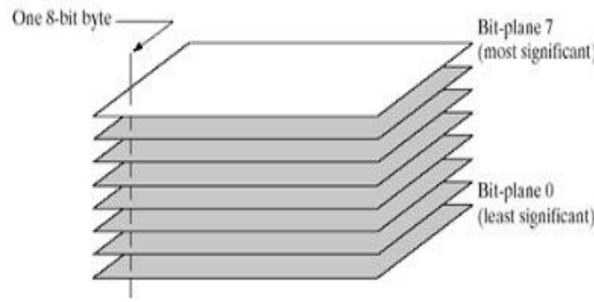



**FIG 11: Bit plane representation of 8 bit image**

Higher-order bits contain the majority of the visually significant data. The other bit planes contribute to more subtle details in the image. Separating a digital image into its bit planes is useful for analyzing the relative importance played by each bit of the image, a process that aids in determining the adequacy of the number of bits used to quantize each pixel. Also, this type of decomposition is useful for image compression.

## 3.SIMULATION RESULTS

The performances of the various methods are analyzed through the MATLAB codings. In this section, we are applying the low contrast input images into each one technique. So that the contrast level of the input images can be improved. According to the analyze various contrast enhancement technique, first we take image negative. We already told that there are three basic types of functions used frequently for image enhancement purpose; linear (negative and identity transformations), logarithamic(log and inverse log transformations) and power law ($n^{th}$ power and $n^{th}$ root transformations). Why we tell this here means the negative transformation comes under the linear transformations. The following flow chart represents the process of the negative transformations.

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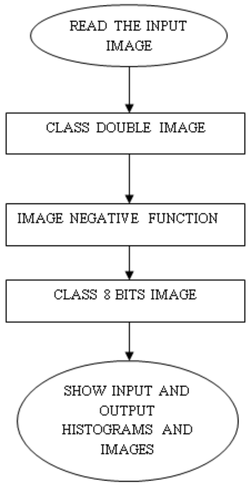


**FIG 12: Flow chart of image negative transformations**

The above figure shows the flow chart representation of the negative transformations. First the input image can be read. After that the input image can be double. Then apply the negative transformation in the input image. Then image can be obtained as class 8 bit image. At last show the input and output images and its corresponding histogram representations. The following figure represents the output resultant image which can be obtained from the negative transformation. Reversing the intensity levels of an image produces a equivalent of photographic negative. This can be processed and obtained in the following figure (13). This type of processing are suitable for enhancing white or gray detail embedded in dark regions of an image, especially when the black areas are dominant in size.

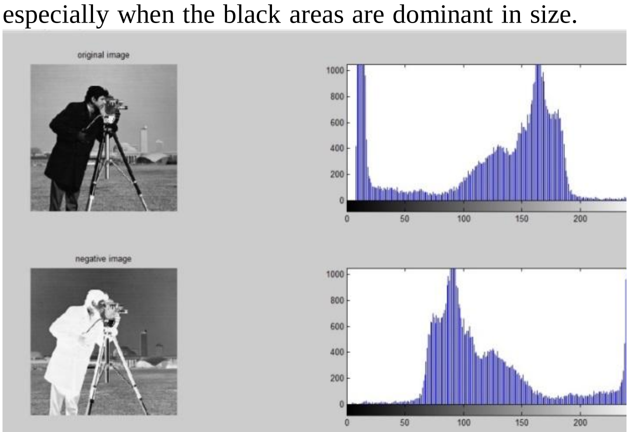


**FIG 13: Original image and resultant image of negative transformation.**

Then and there we are considering the log transformations to improve the contrast level of the input image.

The following figure represents the flow chart of the log transformation method.

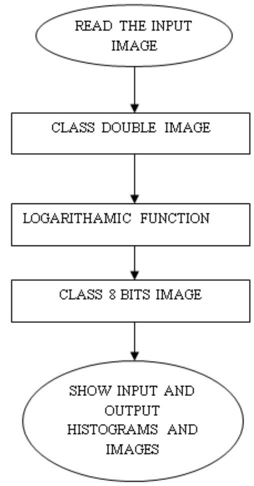


**FIG 14: Flow chart ofLogarithamic transformation**

The process of the logarithamic transformation has illustrated in the above flow chart. The logarithamic transformation maps a narrow range of low gray-level values in the input image into a wide range of output levels. The log function has the important characteristic that it compresses the dynamic range in images with large variations in pixel values. The resultant image of the logarithamic transformation has obtained in the following figure (15).

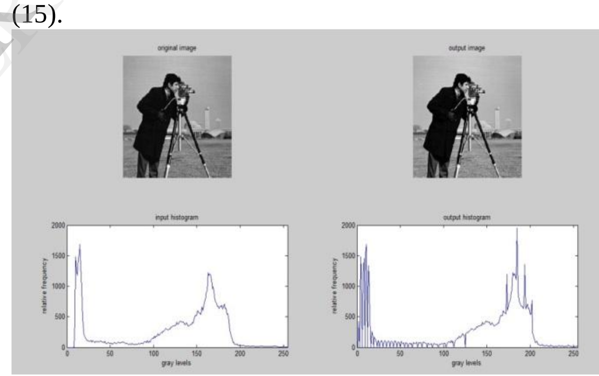

**FIG 15:Original image and resultant image of logarithamic transformation.**

The above figure shows the resultant contrast enhanced image. While comparing to low contrast input image, the resultant output image is contrast enhanced which is mainly depends upon the input gray level r. It is assumed that the gray level value r>=0. The importance of the r value has illustrated in the figure (4). So that the resultant image can be more contrast enhanced.

Subsequent we are moving to the power-law transformations. According to the power-law equation, power law curves with fractional values of gamma map narrow range of dark input values into a wider range of output values with the opposite being true for higher values of input level. So far that, the

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following flow chart will give the process of the power-law transformation.

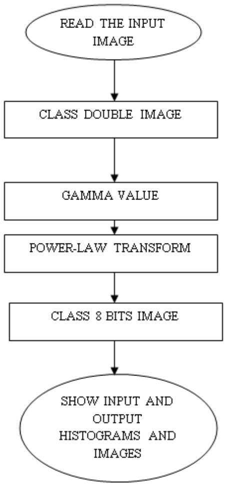


**FIG 16: Flow chart of Power-law transformation**

By pact, the exponent in the power law equation is referred to as the gamma. The process which is used to correct the power-law response phenomenon is referred to as gamma correction. Based on the change in the value of the gamma, there is a important change has taken in the input low contrast images. The following figure (17) shows the result of the power-law transform. The effect of the gamma correction has already illustrated in the figure (8). The figure (17) provides a contrast enhanced image with the help of the power-law transform.

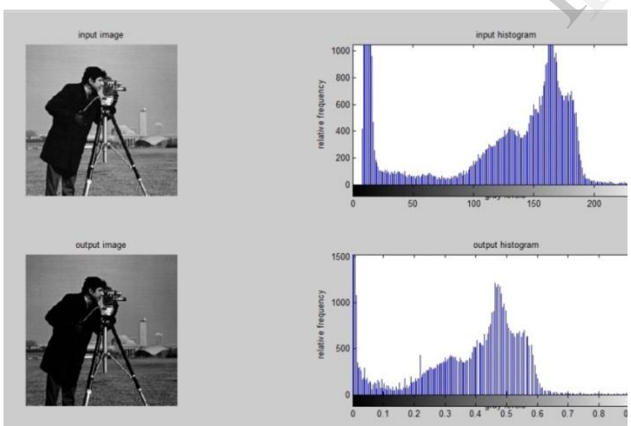


**FIG 17:Original image and resultant image of power-law transformation.**

The following figures show the results of the piece-wise linear transformation functions. The principle advantage of the piece-wise linear transfer functions can be arbitrary complex. In addition to that, the disadvantage of the piece-wise linear transfer function is that their specification requires much user input.

According to the piece-wise linear transfer function, the contrast stretching is the first method. the contrast stretching is most widely used contrast enhancement technique. The idea behind the contrast stretching is to increase the dynamic range of the gray levels in image being processed. The location of the points ($r_1$,$s_1$) and ($r_2$,$s_2$) controls the shape of the transfer functions. The figure (18) shows the result of the contrast stretching process. Based on the location of the points, the gray levels of the image can be increased. Consequently, the figure (19) shows the result of the thresholding. The gray level slicing is used to display the high value for all gray levels in the range and low value for all other gray levels. The figure (20) provides the high lighting the high and low values of the gray levels through gray level scaling.

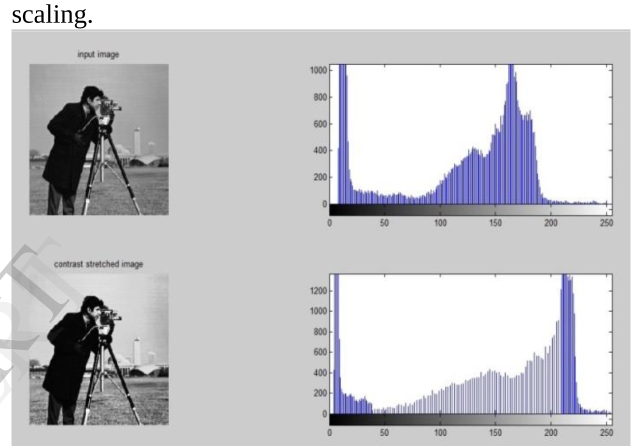


**FIG 18: Original image and resultant image of contrast stretching.**

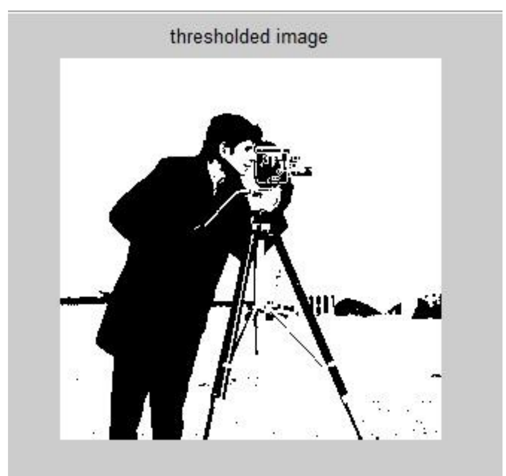


**FIG 19 : Resultant image of thresholding process.**

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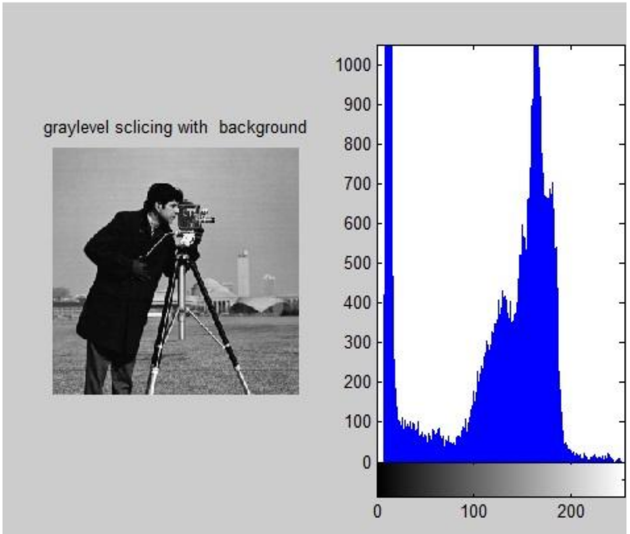


**FIG 20:Resultany image of gray level slicing and its histogram representation.**

After that we are moving to the results of the histogram equalization technique. The following flow chart represents the process of histogram equalization. Histogram equalization is one of the most important and widely used contrast enhancement techniques.

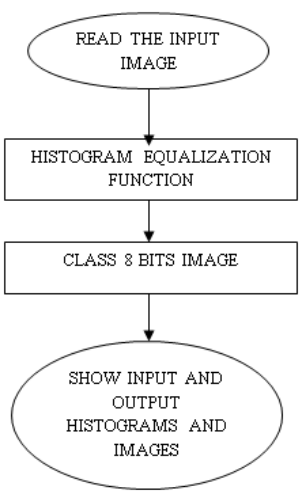


**FIG 19: Flow chart of Histogram equalization**


**FIG 20: Resultant image of Histogram equalization**

Histogram equalization is used to reshape the image histogram to make it flat or wide. It is based on globalintensity properties (the cumulative histogram).By looking at local intensity properties; we can increase the amount of enhancement. The following figure (20) shows the resultant image through histogram equalization process. There are two solutions to increase the amount of enhancement. One solution is to divide an image into regions and perform histogram equalization on each sub-image. Another one is to use local statistics (mean and standard deviation) to enhance the histogram of the image.

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## 4. CONCLUSION

In this paper, we have presented a review of image contrast enhancement techniques. Contrast enhancement plays a vital role in low level image processing, especially low contrast images. Contrast enhancement technique provides better visual perception and color reproduction. For that purpose, this paper deliberated various contrast enhancement techniques. More specifically, we concentrate from the basic techniques to the advance techniques that are involved in the contrast enhancement. The simulation results provide that the proposed algorithms effectively enhance the contrast level of the low contrast input images. Furthermore it provides the process, merits and demerits of the various contrast enhancement techniques.

## REFERENCES

1. R. Gonzalez andR. Woods, *Digital Image Processing*, 3rd ed.EnglewoodCliffs,NJ:Prentice-Hall,2007.
2. Y. Wan,Q. Chen,and B.M. Zhang,"Imageenhancementbasedonequal areadualisticsub-imagehistogramequalization method,"*IEEETrans.Consum.Electron.*,vol.45,no.1,pp.68–75,Feb.1999.
3. "Image Contrast Enhancement Using Histogram ModificationTechnique" Shekhar R. Suralkar 1, Atul H. Karode 2, Manali S. Rathi 3, International Journal of Engineering Research & Technology (IJERT) Vol. 1 Issue 7, September – 2012.
4. "Review Of Image Enhancement Techniques Using Histogram Equalization"ChahatChaudhary, Mahendra Kumar Patil,International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 2, Issue 5, May 2013.
5. "A Survey of Image Processing Technique For Contrast Improvement of An Image" Sachin K. Ingale&Ashish B. Jirapure, International Conference on Electronics and Communication Engineering, April 28th-29th, 2012, Vizag, ISBN: 978-93-81693-56-8.
6. "A Survey on Image Enhancement Methods" Ramkumar.M, Karthikeyan.B, International Journal of Engineering and Technology (IJET), Vol 5 No 2 Apr-May 2013.
7. "Survey Of Image Contrast Enhancement Methods" ChummanLalChandrakar, Monisha Sharma & S. K. Singhai, International Journal of Electronics,Communication& Instrumentation Engineering,Research and Development (IJECIERD),ISSN 2249-684X,Vol.2, Issue 3 Sep 2012 56-63.
8. "A New Enhancement Approach for Enhancing Image of Digital Cameras by Changing the Contrast" ,Dr. Muna F. Al-Samaraie, International Journal of Advanced Science and Technology Vol. 32, July, 2011.
9. "Contrast Stretching Enhancement in Remote Sensing Image",Salem Saleh Al-amri,BIOINFO Sensor Networks,Volume 1, Issue 1, 2011, pp-06-09
10. "Contrast Enhancement for Remote Sensing Images with Discrete Wavelet Transform" ,G.Veena, V.Uma, Ch. Ganapathy Reddy International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-2, Issue-3, July 2013.

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