Hybrid Algorithm Implemented on an Image to Achieve Gaussian Matched Histogram, Desired PDF using Histogram Shifting Technique with EME

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Abstract- An image may be defined as a two dimensional function, f(x,y), where x and y are spatial coordinates and amplitude of f at any pair of coordinates (x, y) is called intensity or gray level of image at that point. Image enhancements are used to make it easier for human visual interpretation and right understanding of imagery. There are lots of techniques used for binary and color image enhancement. By applying these techniques we can enhance or improve many characteristics from given image and we are able to extract lot of information however it is not possible from original image. In this thesis advanced algorithm is used to enhance image for which there are two important method spatial domain and frequency domain method. By using algorithm we are able to plot histogram of original image, histogram of equalized image Gaussian matched histogram. There are three important term histogram processing, histogram equalization and histogram matching (specification).

Keyword- Gaussian, histogram matching, spatial domain, visual, coordinates

I. INTRODUCTION

Enhancements are used to make it easier for visual interpretation and understanding of imagery. The key to understanding contrast enhancements is to understand the concept of an image histogram. A histogram is a graphical representation of the brightness values that comprise an image. The frequency of occurrence of each of these values in the image is shown on the y-axis. By manipulating the range of digital values in an image, graphically represented by its histogram. The simplest type of enhancement is a linear contrast stretch. This involves identifying lower and upper bounds from the histogram (usually the minimum and maximum brightness values in the image) and applying a transformation to stretch this range to fill the full range.

II. BACKGROUND HISTORY

Digital Processing techniques help in manipulation of the digital images by using computers. As raw data from imaging sensors from satellite platform contains deficiencies. To get over such flaws and to get originality of information, it has to undergo various phases of processing. The three general phases that all types of data have to undergo while using digital technique are Pre- processing, enhancement and display, information extraction. Image enhancement techniques can be divided into two broad categories:

- Spatial domain methods, which operate directly on pixels.
- Frequency domain methods, which operate on the Fourier transform of an image.

Spatial Domain Method: The spatial domain processes can be denoted by the expression

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

where f(x, y) is the input image and g(x, y) is the output image and T is an operator on f defined over a neighbourhood of point (x,y). Pixel coordinates (x, y) undergo geometric distortion to produce an image with coordinates (x', y'): r and s are function depending on x and y

$$\begin{aligned} x' &= r(x, y) \\ y' &= s(x, y), \end{aligned}$$

Spatial transformation needed to correct an image is determined through tie points. Following points in the distorted image for which we know their corrected positions in the final image.

$$x' = c1x + c2y + c3xy + c4$$
$$y' = c5x + c6y + c7xy + c8.$$

We can set up the matrix equation using the coordinates of the 4 tie points:

$$\begin{bmatrix} x'_1 \\ y'_1 \\ x'_2 \\ y'_2 \\ x'_3 \\ y'_3 \\ x'_4 \\ y'_4 \end{bmatrix} = \begin{bmatrix} x_1 & y_1 & x_1y_1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & x_1 & y_1 & x_1y_1 & 1 \\ x_2 & y_2 & x_2y_2 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & x_2 & y_2 & x_2y_2 & 1 \\ x_3 & y_3 & x_3y_3 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & x_3 & y_3 & x_3y_3 & 1 \\ x_4 & y_4 & x_4y_4 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & x_4 & y_4 & x_4y_4 & 1 \end{bmatrix} \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \\ c_6 \\ c_7 \\ c_8 \end{bmatrix}$$

Fig. 1 Matrix equation using coordinates of the 4 tie points

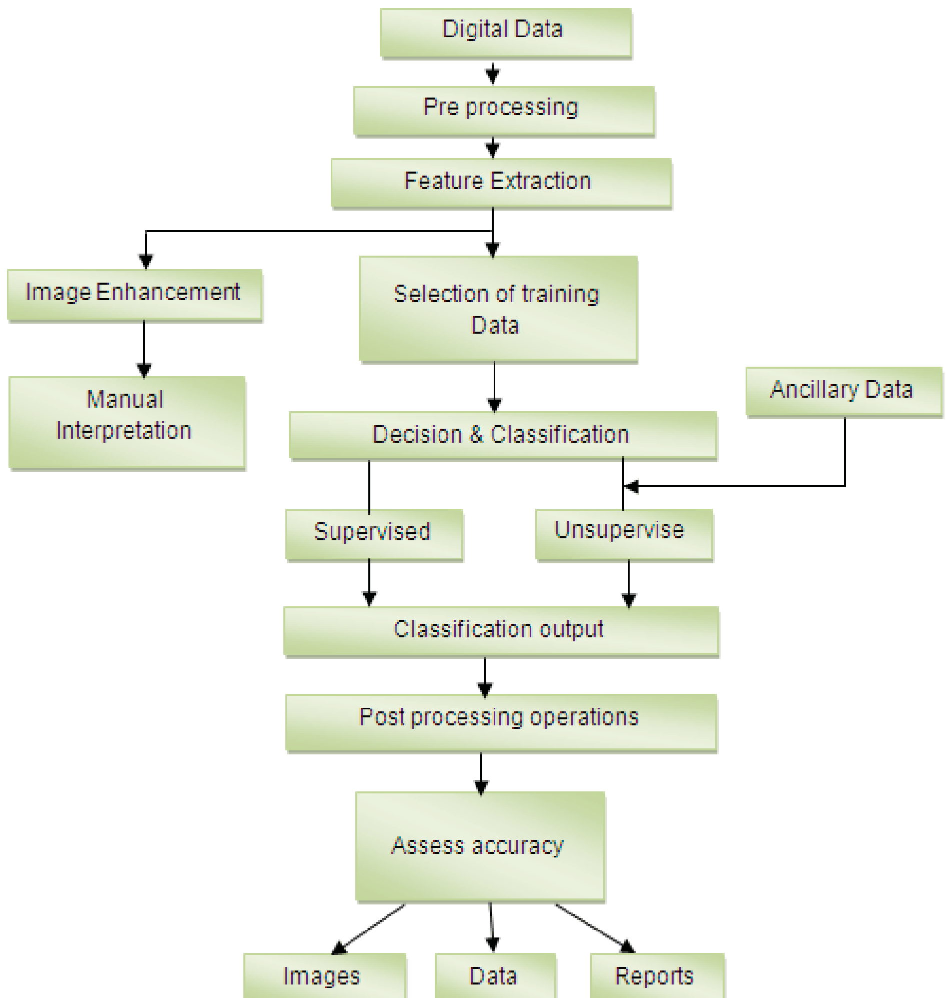

Fig.2. processing stage of an image

Frequency domain method: In frequency domain method we apply Fourier transform on the given image to be enhanced after that multiply the resultant of Fourier transform by a filter and take the inverse transform to get required enhanced image. In ideal case LPF is used which generally block high frequencies and pass only low range frequencies. Images normally consist of light reflected from objects. The basic nature of the image $F(x,y)$ may be characterized by two components: (1) the amount of source light incident on the scene being viewed, and (2) the amount of light reflected by the objects in the scene. These portions of light are called the illumination and reflectance components, and are denoted $i(x,y)$ and $r(x,y)$ respectively. The functions i and r combine multiplicatively to give the image function F:

$$F(x,y) = i(x,y)r(x,y),$$

where $0 < i(x,y) < \infty$ and $0 < r(x,y) < 1$.

$$\mathcal{F}(F(x,y)) \neq \mathcal{F}(i(x,y))\mathcal{F}(r(x,y)).$$

Suppose, however, that we define

$$\begin{aligned} z(x,y) &= \ln F(x,y) \\ &= \ln i(x,y) + \ln r(x,y). \end{aligned}$$

Then

$$\begin{aligned} \mathcal{F}(z(x,y)) &= \mathcal{F}(\ln F(x,y)) \\ &= \mathcal{F}(\ln i(x,y)) + \mathcal{F}(\ln r(x,y)) \end{aligned}$$

$$Z(\omega,\nu) = I(\omega,\nu) + R(\omega,\nu),$$

where *Z*, *I* and *R* are the Fourier transforms of Z, ln i and $\ln r$ respectively. The function *Z* represents the Fourier transform of the *sum* of two images: a low frequency illumination image and a high frequency

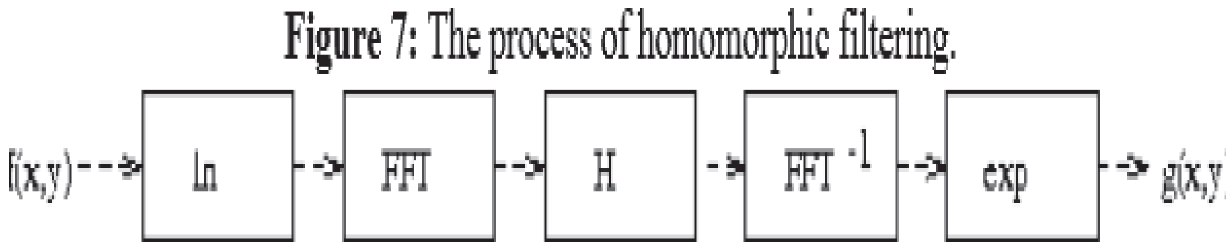

Fig. 3 Homomorphic filtering process

III. DESCRIPTION OF SYSTEM DESIGN AND METHODOLOGY

Point-processing algorithms enhance each pixel separately. With help of advanced algorithm we apply it on binary and color images and as we know images are of many types. Some time it becomes very tedious task to recover information from images because at edges of an image there is chance that information can be destroy so we have to apply very precisely the appropriate filter to get optimize result. There are three important parameter histogram processing, histogram equalization and histogram matching or histogram specification. Histogram of a digital image with intensity level in the range of [0, L-1] is a discrete function $h(r_k) = n_k$ where r_k is the k^{th} intensity level and n_k is no of pixel in the image with intensity r_k. Histogram enhances the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Using, this intensities can be better distributed on the histogram. It allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values

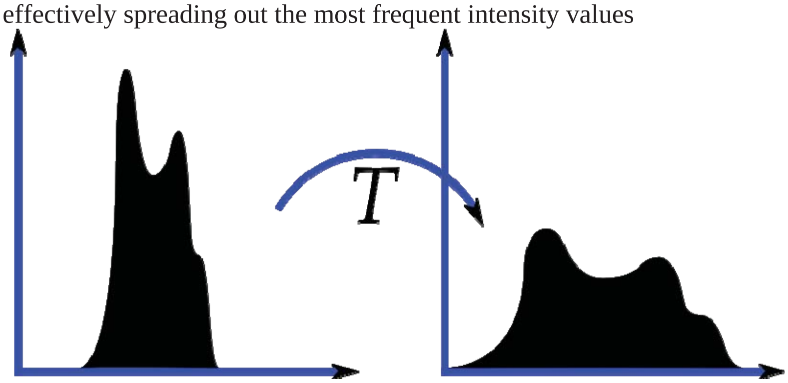

Fig. 4 Histogram equalization

The method is useful in images with front and back grounds that are both bright or both dark. There are two ways to think about and implement histogram equalization, either as image change or as palette change. The operation can be expressed as *P (M (I))* where *I* is the original image, *M* is histogram equalization mapping operation and *P* is a palette.

Implementation: Consider a discrete gray scale image {*x*} and let n_i be the number of occurrences of gray level *i*. The probability of an occurrence of a pixel of level *i* in the image is

$$p_x(i) = p(x = i) = \frac{n_i}{n}, \quad 0 \le i < L$$

L being the total number of gray levels in the image (0 to 255),

n = total number of pixels in image, and $p_x(i)$ image's histogram for pixel value i, normalized to [0,1].

Cumulative distribution function corresponding to p_x as

$$cdf_x(i) = \sum_{j=0}^{i} p_x(j),$$

which is also the image's accumulated normalized histogram.

We would like to create a transformation of the form *y* = *T*(*x*) to produce a new image {*y*}, with a flat histogram. Such an image would have a linearized CDF across the value range, i.e.

$$cdf_y(i) = ik$$

for some constant *K*. The properties of the CDF allow us to perform such a transform it defined as

$$y = T(k) = cdf_x(k)$$

where *k* is in the range [0,L). Notice that T maps the levels into the range [0,1], since we used a normalized histogram of {x}. In order to map the values back into their original range, the following simple transformation needs to be applied on the result:

$$y' = y \cdot (\max\{x\} - \min\{x\}) + \min\{x\}$$

IV. RESULT

Consider an image for which we have to show wavelet decomposition, histogram shifting and enhanced image. For enhanced image we changed the value of k and get different value of EME and there is a table listed below for different value of K and EME.

Fig.5 original image

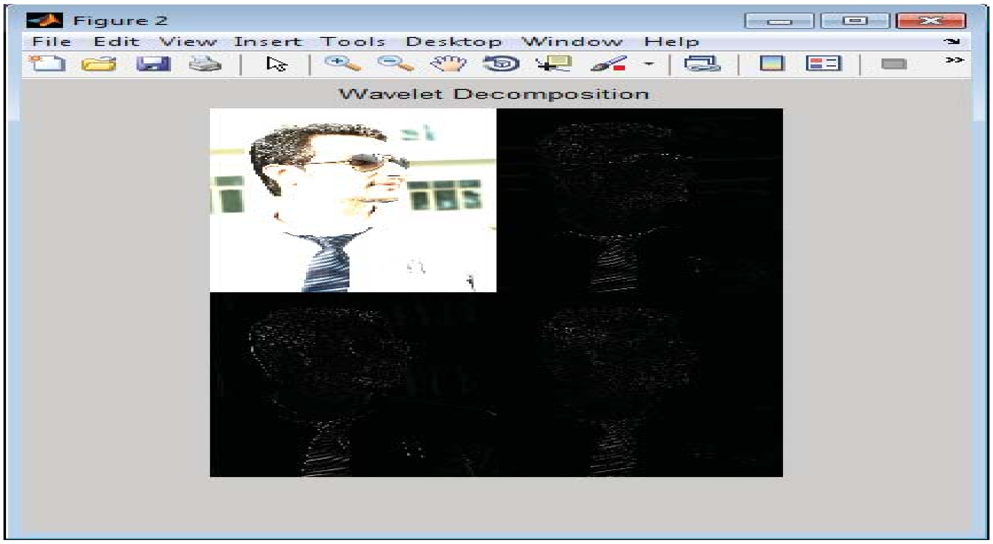

Fig.6 wavelet decomposition of original image

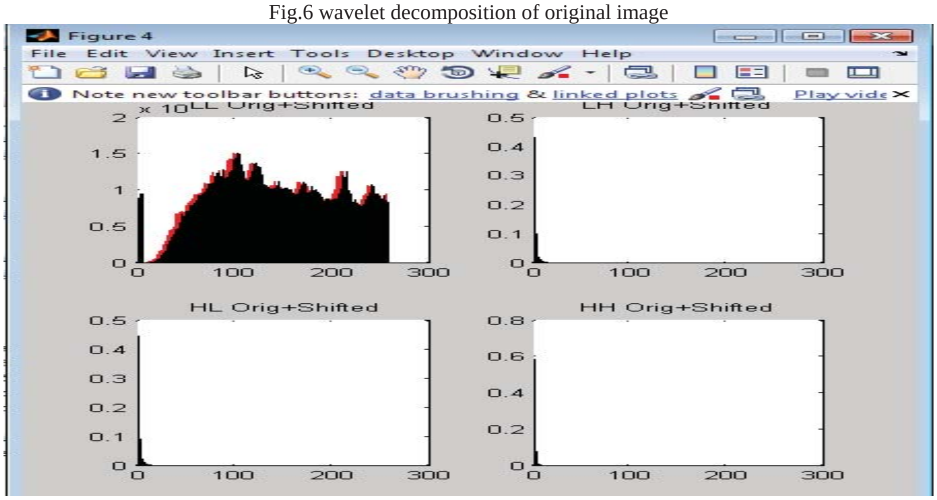

Fig.7 Histogram shifting of original image

Fig.8 Enhanced image original image

Sr. No.	K1	K2	K3	K4	EME
1	5	0	0	0	6.1274
2	1	2	3	4	5.8907
3	3	6	9	12	6.0547
4	4	8	12	16	6.0880
5	7	14	21	28	6.1292

Table I with different vale of EME by altering K

(ii)

Fig.9 original image

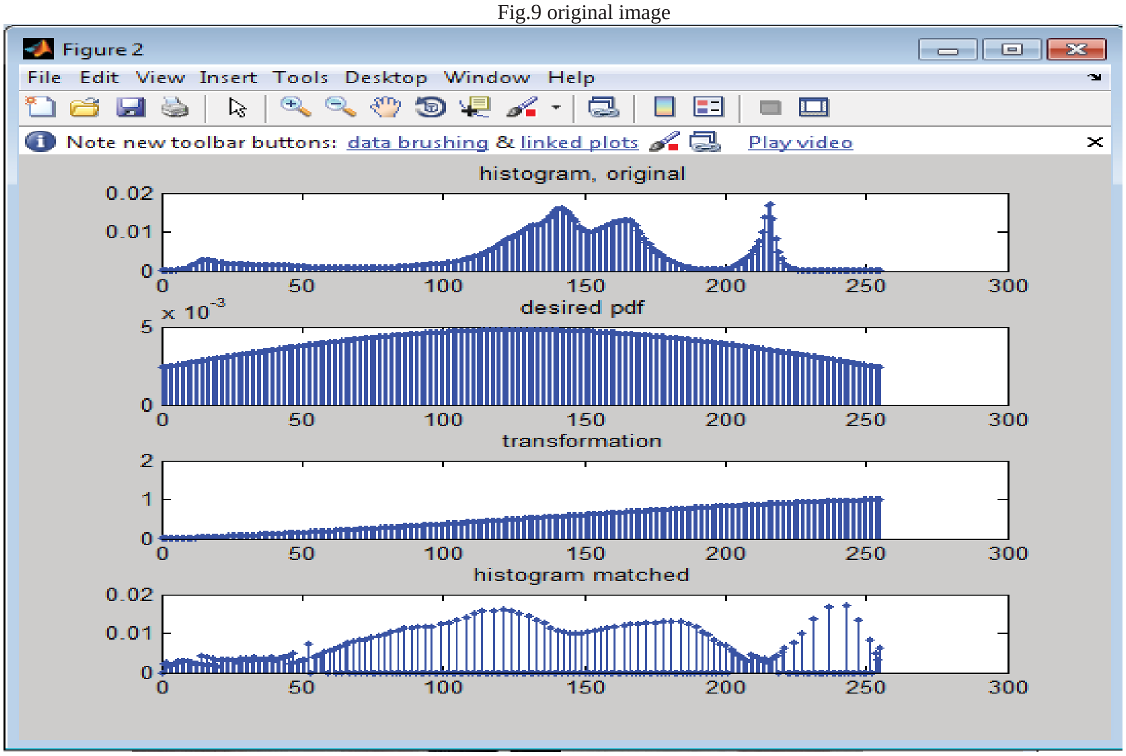

Fig.10 original histogram, desired pdf , transformation, histogram matched

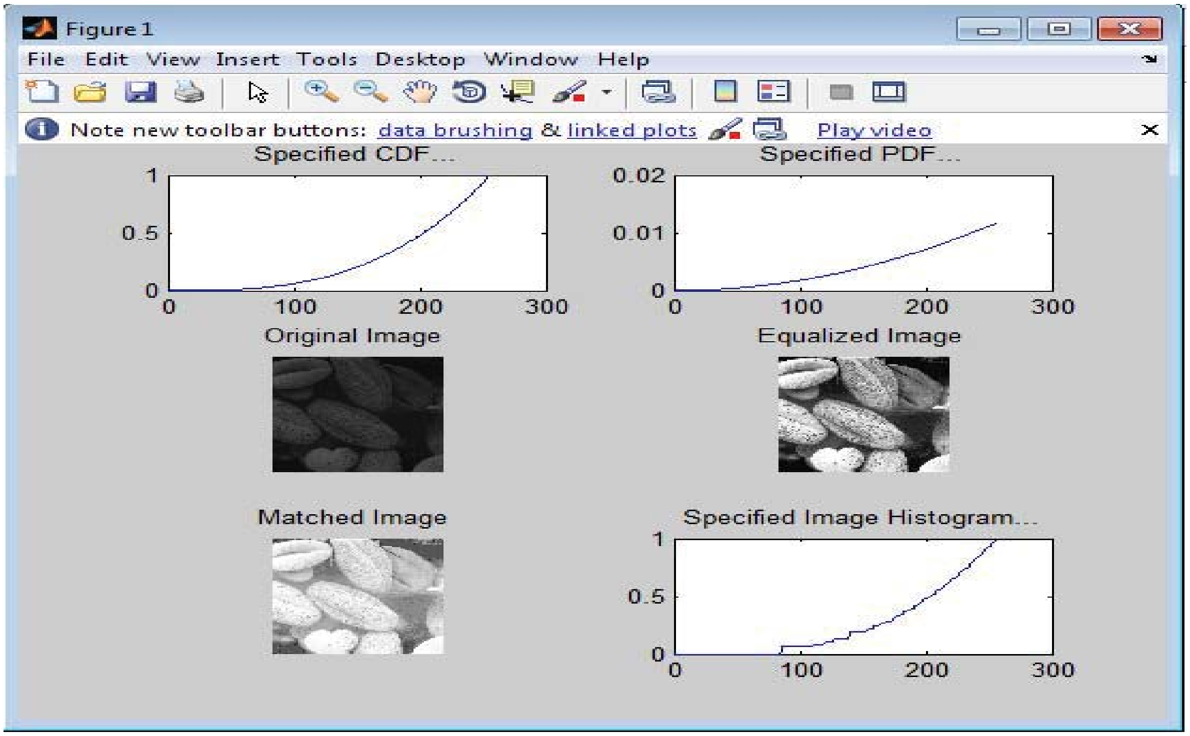

Fig.11 Gaussian matched histogram

(iii) In this result specific cdf , specific pdf , equalized image, matched image and specified image histogram will be shown

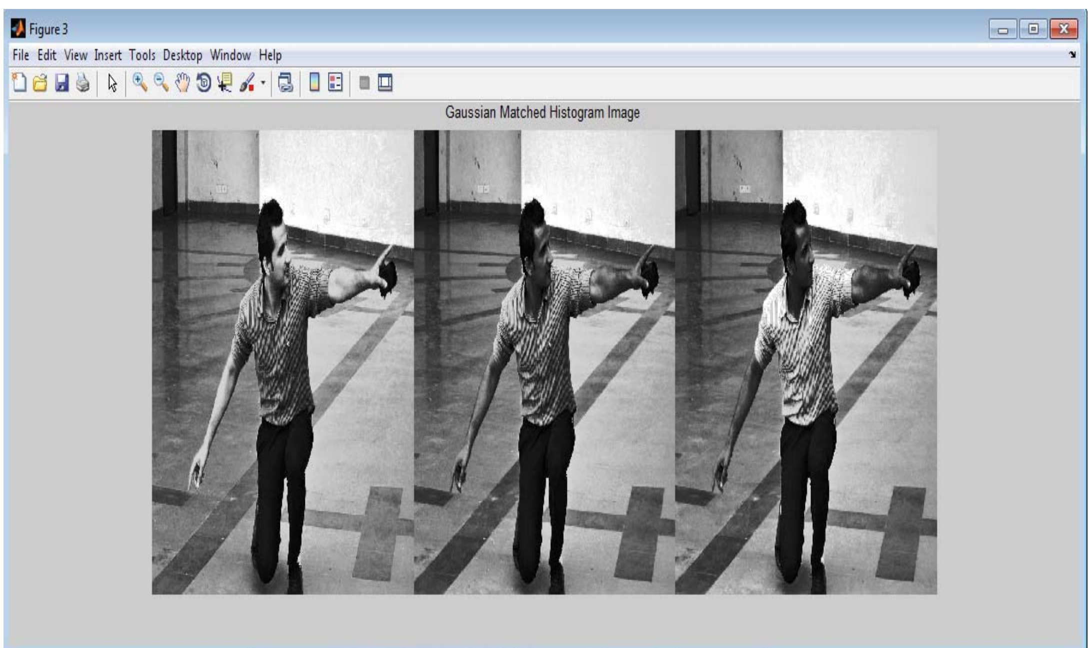

Fig.12 Gaussian matched histogram

(iv): Using advanced algorithm how a binary image can be improved or enhance with equalized histogram is shown below

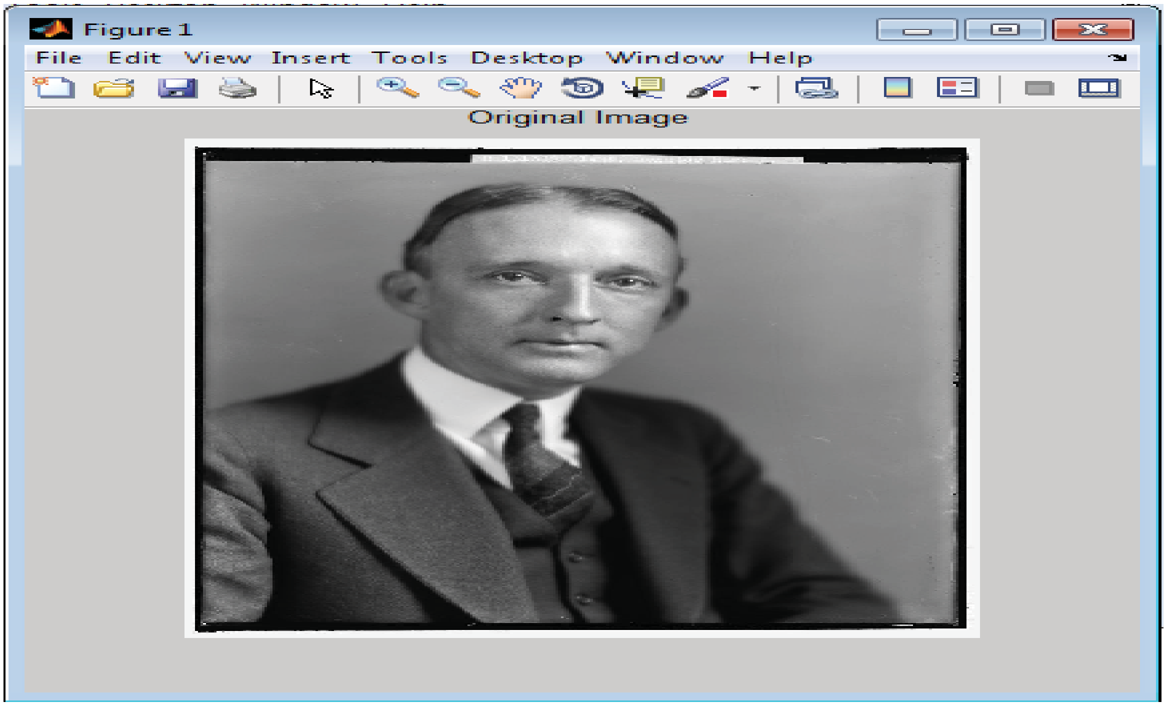

Fig.13 original image

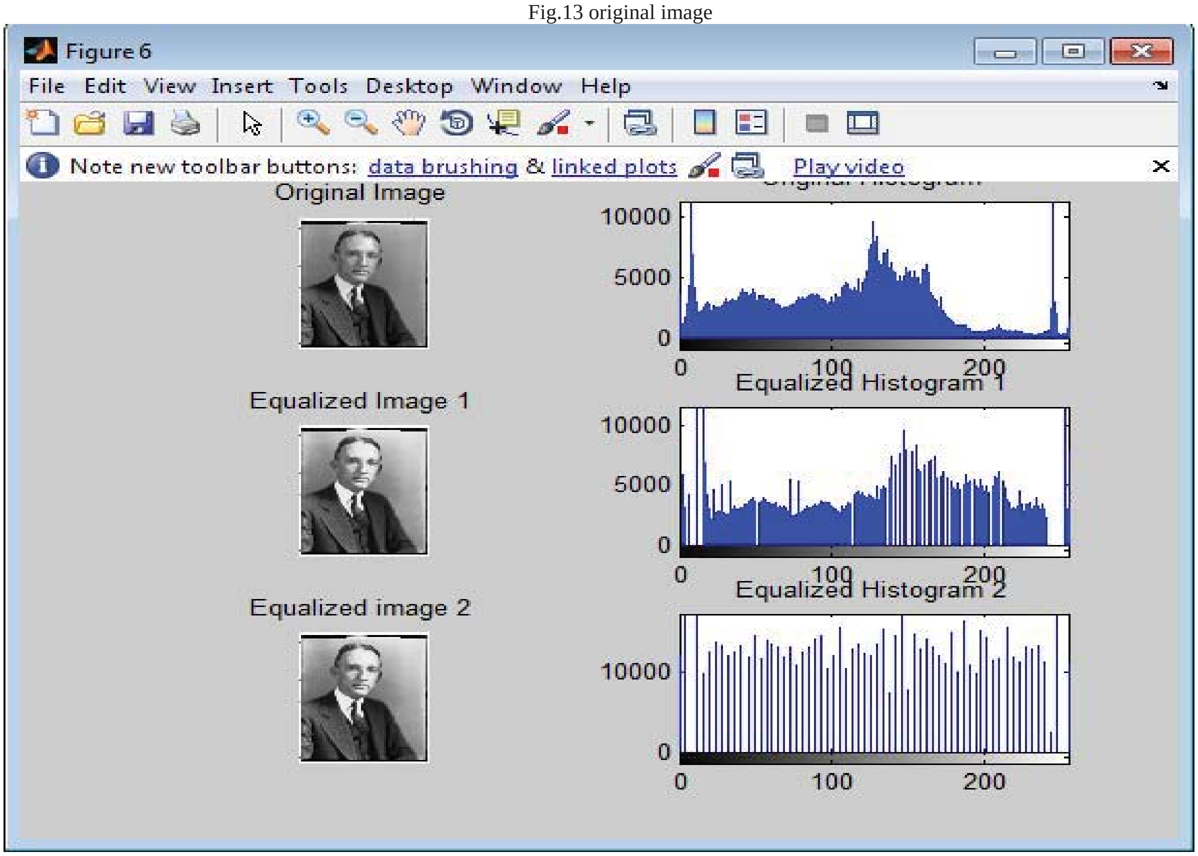

Fig.14 Original image and it's histogram, equalized image1 and 2 with their histogram

IV. CONCLUSION

Using advance algorithm we can recover histogram, equalized histogram, gaussian matched equalization, histogram desired pdf, equalization function, wavelet decomposition and many more result. By changing scaling factor we get EME and image enhanced significantly from which lot of information caan be recovered.

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