Chapter 1

INTRODUCTION

INTRODUCTION

Images are the most common and convenient means of conveying or transmitting information. An image is worth a thousand words. Image concisely conveys information about positions, sizes and inter-relationships between objects. They portray spatial information that we can recognize as objects. Human beings are good at deriving information from such images, because of our innate visual and mental abilities. About 75% of the information received by human is in pictorial form.

1.1 DIGITAL IMAGE PROCESSING

1.1.1 Back ground:

Digital image processing is an area characterized by the need for extensive experimental work to establish the viability of proposed solutions to a given problem. An important characteristic underlying the design of image processing systems is the significant level of testing and experimentation that normally is required before arriving at an acceptable solution. This characteristic implies that the ability to formulate approaches and quickly prototype candidate solutions generally plays a major role in reducing the cost & time required to arrive at a viable system implementation.

1.1.2 What is Digital Image Processing?

An image may be defined as a two-dimensional function f(x, y), where x & y are spatial coordinates, & the amplitude off at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y & the amplitude values of fare all finite discrete quantities, we call the image as digital image. The field of DIP refers to processing digital image by means of digital computer. Digital image is composed of a finite number of elements, each of which has a particular location & value. The elements are called pixels.

Vision is the most advanced of our sensor, so it is not surprising that image play the single most important role in human perception. However, unlike humans, who are limited to the visual band of the EM spectrum imaging machines cover almost the entire EM spectrum, ranging from gamma to radio waves. They can operate also on images generated by sources that humans are not accustomed to associating with images.

There are no clear-cut boundaries in the continue from image processing at one end to complete vision at the other. Low-level process involves primitive operations such as image processing to reduce noise, contrast enhancement & image sharpening. A low- level process is characterized by the fact that both its inputs & outputs are images. Digital image processing, as already defined is used successfully in a broad range of areas of exceptional social & economic value.

1.1.3 What is an Image?

An image is represented as a two dimensional function f(x, y) where x and y are spatial co-ordinates and the amplitude of 'f' at any pair of coordinates (x, y) is called the intensity of the image at that point.

1.1.4 Gray Scale Image:

A grayscale image is a function I (xylem) of the two spatial coordinates of the image plane. I(x, y) is the intensity of the image at the point (x, y) on the image plane.

1.1.5 Color Image:

It can be represented by three functions, R (xylem) for red G(xylem) for green and B (xylem) for blue.

An image may be continuous with respect to the x and y coordinates and also in amplitude. Converting such an image to digital form requires that the coordinates as well as the amplitude to be digitized. Digitizing the coordinate's values is called sampling. Digitizing the amplitude values is called quantization.

1.1.6 Coordinate Convention:

The result of sampling and quantization is a matrix of real numbers. We use two principal ways to represent digital images. Assume that an image f(x, y) is sampled so that the resulting image has M rows and N columns. We say that the image is of size M X N. The values of the coordinates (xylem) are discrete quantities. For notational clarity and convenience, we use integer values for these discrete coordinates.

In many image processing books, the image origin is defined to be at (xylem)=(0,0).The next coordinate values along the first row of the image are (xylem)=(0,1).

It is important to keep in mind that the notation (0,1) is used to signify the second sample along the first row. It does not mean that these are the actual values of physical coordinates when the image was sampled.

1.1.7 Image as Matrices

The preceding discussion leads to the following representation for a digitized image function.

$$f = \begin{bmatrix} f(0,0) & f((0,1) \ldots \ldots \ldots & f(0,N-1) \\ f(1,0) & f(1,1) \ldots \ldots \ldots & f(1,N-1) \\ f(M-1,0) & f(M-1,1) \ldots \ldots \ldots & f(M-1,N-1) \end{bmatrix}$$

The right side of this equation is a digital image by definition. Each element of this array is called an image element, picture element, pixel or Pel. The terms image and pixel are used throughout the rest of our discussions to denote a digital image and its elements.

A digital image can be represented naturally as a

$$f = \begin{bmatrix} f(1,1) & f(1,2) \ldots \ldots \ldots & f(1,N) \\ f(2,1) & f(2,2) \ldots \ldots \ldots & f(2,N) \\ f(M,1) & f(M,2) \ldots \ldots \ldots & f(M,N) \end{bmatrix}$$

Where f (1,1) = f(0,0) clearly the two representations are identical, except for the shift in origin. The notation f(x, y) denotes the element located in row p and the column q.

1.2 IMAGE TYPES

The toolbox supports four types of images:

1 .Intensity images

2. Binary images

3. Indexed images

4. RGB images.

Most monochrome image processing operations are carried out using binary or intensity images, so our initial focus is on these two image types. Indexed and RGB color images.

1.2.1 Intensity Images:

An intensity image is a data matrix whose values have been scaled to represent intentions. When the elements of an intensity image are of class unit8, or class unit 16, they have integer values in the range [0,255] and [0, 65535], respectively. If the image is of class double, the values are floating point numbers. Values of scaled, double intensity images are in the range [0, 1] by convention.

1.2.2 Binary Images:

Binary images have a very specific meaning in MATLAB.A binary image is a logical array 0's and1's.Thus, an array of 0's and 1's whose values are of data class, say unit8, is not considered as a binary image in MATLAB .A numeric array is converted to binary using function logical. Thus, if A is a numeric array consisting of 0's and 1's, we create an array B using the statement

B=logical (A)

If A contains elements other than 0's and 1's.Use of the logical function converts all nonzero quantities to logical 1's and all entries with value 0 to logical 0's.Using relational and logical operators also creates logical arrays. To test if an array is logical we use the logical function: is logical(c). If c is a logical array, this function returns a 1.Otherwise returns a 0. Logical array can be converted to numeric arrays using the data class conversion functions.

1.2.3 Indexed Images:

An indexed image has two components:

1. A data matrix integer, x
2. A color map matrix, map

Matrix map is an m*3 arrays of class double containing floating point values in the range [0, 1].The length m of the map are equal to the number of colors it defines. Each row of map specifies the red, green and blue components of a single color. An indexed images uses "direct mapping" of pixel intensity values color map values. The color of each pixel is determined by using the corresponding value the integer matrix x as a pointer in to map.

If x is of class double ,then all of its components with values less than or equal to 1 point to the first row in map, all components with value 2 point to the second row and so on.

If x is of class units or unit 16, then all components value 0 point to the first row in map, all components with value 1 point to the second and so on.

1.2.4 RGB Images:

An RGB color image is an M*N*3 array of color pixels where each color pixel is triplet corresponding to the red, green and blue components of an RGB image, at a specific spatial location. An RGB image may be viewed as “stack” of three gray scale images that when fed in to the red, green and blue inputs of a color monitor produce a color image on the screen. Convention the three images forming an RGB color image are referred to as the red, green and blue components images. The data class of the components images determines their range of values. If an RGB image is of class double the range of values is [0, 1].

Similarly the range of values is [0,255] or [0, 65535].For RGB images of class units or unit 16 respectively. The number of bits use to represents the pixel values of the component images determines the bit depth of an RGB image. For example, if each component image is an 8bit image, the corresponding RGB image is said to be 24 bits deep.

Generally, the number of bits in all component images is the same. In this case the number of possible color in an RGB image is (2^b) ^3, where b is a number of bits in each component image. For the 8bit case the number is 16,777,216 colors.

1.3 TYPES OF IMAGE PROCESSING

There are three types of image processing. They are

1. Image Segmentation

2. Image Data Compression

3. Image Restoration

4. Image Enhancement

1.3.1 Image Segmentation:

The processing of partitioning of digital image into multiple regions (set of pixels) is called segmentation. Segmentation of an image entails the division or separation of image into region of similar attribute.

Fig 1.1 Original Image **Fig 1.2 Segmented image**

Fig 1.1 is the original image of vegetables; the segmented image is obtained by varying the attributes of original image as shown in fig1.2

1.3.2 Image Data Compression:

Image data compression techniques are concerned with reduction with number of bits required to store or transmit images without any appreciable loss of information.

Fig 1.3Original Image ***Fig 1.4 Compressed Image***

Fig 1.3 is the original image of the tiger, compressed image is obtained by reducing the number of bits required to store as shown in fig 1.4.

1.3.3 Image Restoration:

Image restoration refers to removal or minimization of degradations in an image. Image restoration differs from Image enhancement.

Restoration techniques depend only on class or ensemble properties of data set where as a image enhancement techniques are much more image dependent. Many digital image processing techniques are available. We are going to concentrate on image enhancement.

1.4 IMAGE ENHANCEMENT:

The image enhancement is one of the significant techniques in digital image processing. It has an important role in various fields where images are to be understood and analyzed. Image enhancement is done on an image to improve its visual effects and quality or to make it more appropriate for further processing by another application. An image can have low contrast or bad quality due to a number of reasons like poor quality of imaging device, adverse external conditions at the time of image acquisition and many more.

Image enhancement plays a fundamental role in image processing applications where people (the expert) make decisions with respect to the image information. Form of image enhancement include noise reduction, edge enhancement and contrast enhancement.

Enhancement may be the technique of improving the superiority of an electrically stored image. To produce a picture lighter or darker or to increase or decrease contrast. Image enhancement is to improve the sensitivity of information in images for human viewers, or to offer enhanced input for other regular image processing techniques. In this procedure, more than one attributes of the image are customized. The possibility of attributes and the direction they are customized are specific to certain task.

For example a forensic images or videos employ technique that resolves the problem of low resolution and motion blur while medical imaging benefits more from increased contrast and sharpness. Thus, for example, a method that is quite useful for enhancing x-ray images may not be the best approach for enhancing satellite images taken in the infrared band of the electromagnetic spectrum.

There is no general theory of image enhancement, when an image is processed for visual interpretation, the viewer is the ultimate judge of how well a particular method works.

Fig 1.5 Original Image

Fig 1.6 Enhanced image

Fig 1.5 is the low contrast image and the enhanced image is obtained by varying properties

Of the image as shown in fig.1.6.

Chapter 2

LITERATURE SURVEY

LITERATURE SURVEY

Image enhancement is a common approach to improve the quality of those images in terms of human visual perception. Enhancement techniques can be divided into two categories namely:

1. Spatial domain methods
2. Transform domain methods

Spatial domain technique enhances an image by directly dealing with the intensity value in an image. Transform domain enhancement techniques involve transforming the image intensity data into a specific domain by using methods such as DFT, DCT, etc. and the image is enhanced by altering the frequency content of the image.

We are going to concentrate on the spatial domain methods. More spatial domain techniques are available for is, some of them are

1. Linear transformations
2. Logarithmic transformations
3. Piece-wise linear transformations

2.1 LINEAR TRANSFORMATIONS

Negative of the image or inverting the pixel of the image is one of the methods in image enhancement process. Image negatives are calculated by negative transformation with the intensity level is present in the range of [0, L-1].It is represented by the formula

$$S = L\text{-}1\text{-}r \text{………….} \quad (2.1)$$

Photographic negative of an image is obtained by reversing or inverting the intensity level of the image by using the equation 2.1. In an image, if the darker areas are predominant and larger means we can apply this technique for improving the grey or white information combined with darker parts of the image. In Identity transformation whatever the input is given output appears.

Fig 2.1Negative transformed image ***Fig 2.2 Identity image***

Fig 2.1 is the Negative of the image obtained by reversing the intensity level of the image.

Fig 2.2 is same as the input image known as identity of the image.

2.2 LOGARITHMIC TRANSFORMATION:

Log transformations are mathematically expressed using the equation

$S = C \log (1+r)$………….. (2.2)

Where C is taken as constant. It is taken that $r>=0$. By using this log transformation darker pixel values of the image are expanded by compressing the values in the higher levels as given the equation (2.2).

For inverse log transformation function the process is done at the reverse order. Compression of dynamic range values in an image by giving large variation in the pixel value is considered as the main characteristics of log transformation. These techniques are mainly used in security surveillance applications.

Fig 2.3 Log transformed image

Fig 2.3 is the log transformed image obtained by compressing the bright pixel values and expanding the dark pixel values

2.3 PIECE-WISE LINEAR TRANSFORMATION

In this transformation each pixel value of the image is manipulated. This transformation technique is used for enhancing the quality of the image by altering the range of values.

The types are

- Contrast stretching method
- Intensity level slicing method
- Bit plane slicing method

2.3.1 Contrast stretching :

Contrast stretching is treated as easiest and simplest methods of linear transformation functions. Improper illumination occurrence in low contrast value, in image sensor there will be loss of dynamic value and also in acquisition of image wrong placement of lens aperture may happen during processing the image. According to the display device contrast stretching will expand the intensity level range in the respective image such that it covers the full intensity value.

Fig: 2.4 Contrast stretched image

Fig 2.4 is the image that covers all the intensity values of the image to recover the loss of dynamic values during image acquisition.

2.3.2 Intensity level slicing:

It is basically used to improve the quality of image. Specific range of intensity of the image is highlighted in intensity level slicing method. It can be implemented in several ways, but most are the variations of two themes. In first approach one value is mapped with similar range of interest and other with similar range of intensities. Next approach is slicing the pixel values bit by bit.

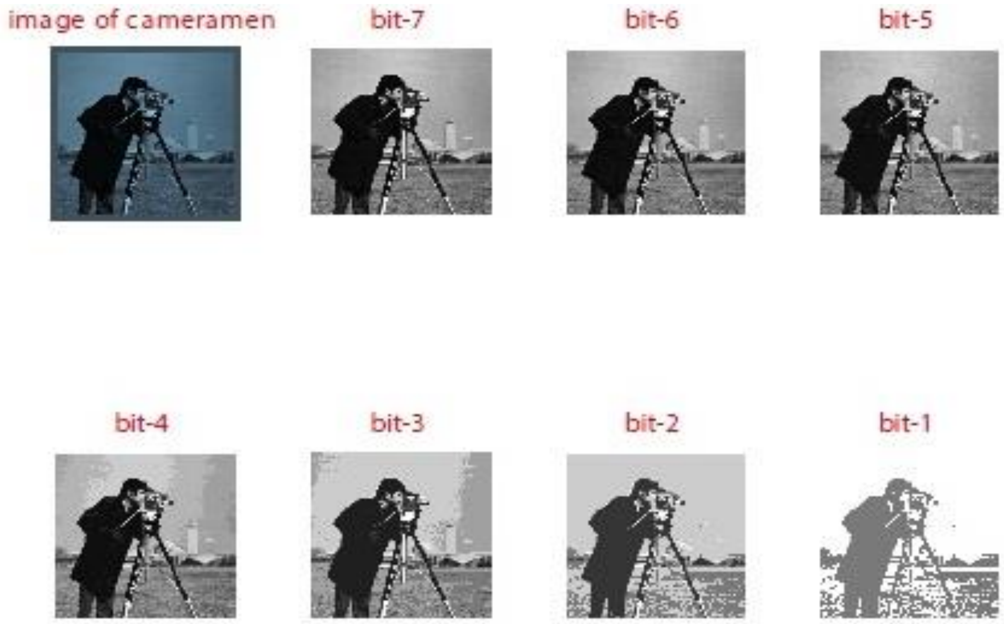

Fig 2.5Images of intensity level slicing

Fig 2.5 representing the images slicing the bit pixel values bit by bit based on intensity levels, by varying the pixel values image is enhanced if number of bits increases

2.3.3 Bit plane slicing:

In an image pixels are represented as the digital values defined bit by bit. Suppose the intensity of each and every pixel in a grey scale image having 256 bits is composed of 8 bits each, then we can highlight the appearance of the overall image by specific group of bits instead of highlighting the range of intensity level. Relative importance of an image is analyzed in the image bit by bit using decomposition of an image into its respective bit planes.

Quantization of image is done determining the adequacy of bits that is produced as a whole. This is the procedure done in bit plane slicing as shown in fig 2.6

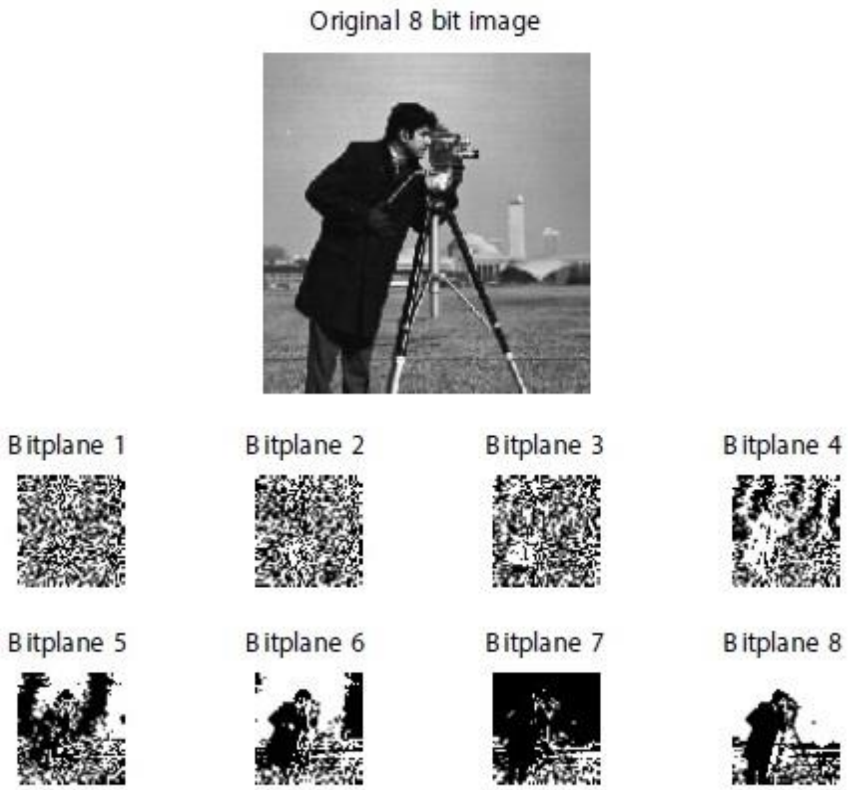

Fig 2.6 Images of Bit plane slicing

Fig 2.6 is an example of Bit plane slicing image, where the regions of interest are highlighted by decomposing the image into respective bit planes. The more the number of bit planes the more the image will be enhanced

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2.4 TRANSFORM DOMAIN METHODS:

This is a more complex way of hiding information in an image. Various algorithms and transformations are used on the image to hide information in it. Transform domain embedding can be termed as a domain of embedding techniques for which a number of algorithms have been suggested. The process of embedding data in the frequency domain of a signal is much stronger than embedding principles that operate in the time domain.

Most of the strong steganographic systems today operate within the transform domain Transform domain techniques have an advantage over spatial domain techniques as they hide information in areas of the image that are less exposed to compression, cropping, and image processing. Some transform domain techniques do not seem dependent on the image format and they may outrun lossless and lossy format conversions. Transform domain techniques are broadly classified into:

1.Discrete Fourier transformation technique (DFT).

2.Discrete cosine transformation technique (DCT).

3.Discrete Wavelet transformation technique (DWT)

2.4.1 DISCRETE FOURIER TRANSFORMATION TECHNIQUE (DFT):

The DFT is the most important discrete transform used to perform fourier analysis in many practical applications. In digital signal processing, the function is any quantity or signal that varies over time, such as the pressure of a sound wave, a radio signal, or daily temperature readings, sampled over a finite time interval. The discrete fourier transform (DFT) converts a finite sequence of equally-spaced samples of a function into a same-length sequence of equally-spaced samples of the discrete-time fourier transform (DTFT), which is a complex-valued function of frequency. The interval at which the DTFT is sampled is the reciprocal of the duration of the input sequence.

2.4.2 DISCRETE COSINE TRANSFORMATION TECHNIQUE (DCT):

In particular, a DCT is a Fourier-related transform similar to the discrete fourier transform (DFT), but using only real numbers. The DCTs are generally related to fourier series coefficients of a periodically and symmetrically extended sequence whereas DFTs are related to fourier series coefficients of a periodically extended sequence. DCTs are equivalent to DFTs of roughly twice the length, operating on real data with even symmetry (since the fourier transform of a real and even function is real and even), whereas in some variants the input and/or output data are shifted by half a sample.

DCTs are important to numerous applications in science and engineering, from lossy compression of audio and images (where small high-frequency components can be discarded), to spectral methods for the numerical solution of partial differential equations.

The use of cosine rather than sine functions is critical for compression, since it turns out that fewer cosine functions are needed to approximate a typical signal, whereas for differential equations the cosines express a particular choice of boundary conditions.

2.4.3 DISCRETE WAVELET TRANSFORMATION TECHNIQUE (DWT):

The discrete wavelet transform has a huge number of applications in science, engineering, mathematics and computer science. Most notably, it is used for signal coding, to represent a discrete signal in a more redundant form, often as a preconditioning for data compression. Practical applications can also be found in signal processing of accelerations for gait analysis, image processing, in digital communications and many others.

It is shown that discrete wavelet transform (discrete in scale and shift, and continuous in time) is successfully implemented as analog filter bank in biomedical signal processing for design of low-power pacemakers and also in ultra-wideband (UWB) wireless communications.

2.5 IMAGE ENHANCEMENT TECHNIQUES:

The main objective of image enhancement is to process the image so that the ouput image will be better compare to input image. So this technique enhance and improve the quality of the image.

- Highlighting interesting details in images.
- Making images more visually appealing.

Images enhancement is divides into 2 types. They are

1)Local Enhancement

2)Global Enhancement

2.5.1 LOCAL ENHANCEMENT:

The local enhancement is employed to get the minute details of an image. It enhances the local details in terms of the gradient of the image which gives useful information to the analyzer of the image. It addresses those pixels which would be ignored by the global method.

The local enhancement method employed here is unsharp masking. In this method the image is sharpened by subtracting an unsharp image, that is a blurred or smoothed from the original image, so the name unsharp masking is derived. In this method the following steps are involved:

1. Blurring of the image.

2. Subtracting the blurred image from the original image to make the mask.

3. Adding the mask to the original image.

Fig: ***2.7 Original image***

Fig: 2.8 Blurred image

Fig: 2.9 Original image

Fig: 2.10 Sharpen image

2.5.2 GLOBAL ENHANCEMENT:

The global enhancement of the image is used to increase the contrast of the image. In this process each pixel of the image is adjusted so that it gives a better visualization of the image.

HISTOGRAM EQUALIZATION:

Histogram processing is used in image enhancement the information inherent in histogram can also used in other image processing application such as image segmentation and image compression. A histogram simply plots the frequency at which each grey-level occurs from 0 (black) to 255 (white).

Histogram processing should be the initial step in preprocessing. To produce a much better image histogram equalization and histogram specification (matching) are two methods widely used to modify the histogram of an image.

Histogram represents the frequency of occurrence of all gray-level in the image, that means it tell us how the values of individual pixel in an image are distributed and it is given as (3.5).

$$h(r_k) = \frac{n_k}{N} \quad \ldots\ldots\ldots\ldots (3.5)$$

Where$r_k$and $n_k$are intensity level and number of pixels in image with intensity r_k respectively.

Histogram equalization is a common technique for enhancing the appearance of images. Suppose we have an image which is predominantly dark. Then its histogram would be skewed towards the lower end of the grey scale and all the image detail is compressed into the dark end of the histogram.

If we could `stretch out' the grey levels at the dark end to produce a more uniformly distributed histogram then the image would become much clearer.

Histogram equalization stretches the histogram across the entire spectrum of pixels (0 – 255). It increases the contrast of images for the finality of human inspection and can be applied to normalize illumination variations in image understanding problems.

Histogram equalization is one of the operations that can be applied to obtain new images based on histogram specification or modification. Histogram equalization is considered a global technique.

The main purpose of histogram equalization is to find gray level transformation function T to transform image f such that the histogram of T (f) is equalized.

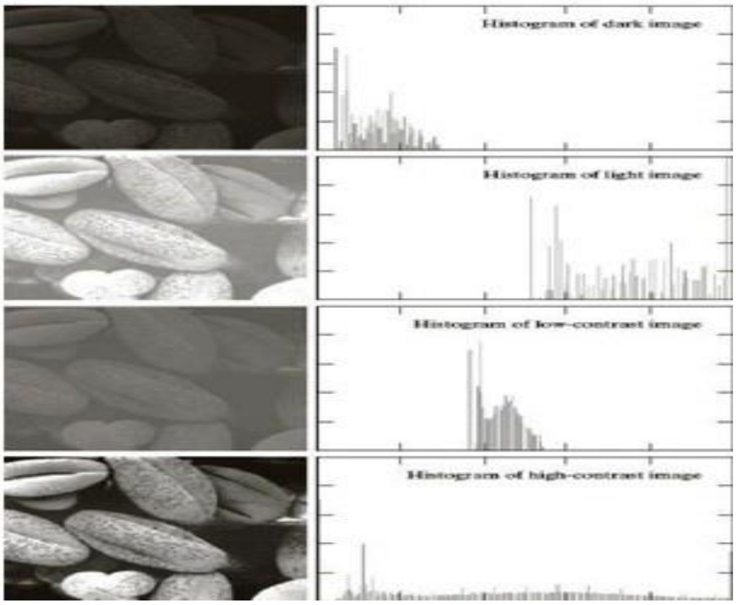


Fig 2.11 Simple Histogram

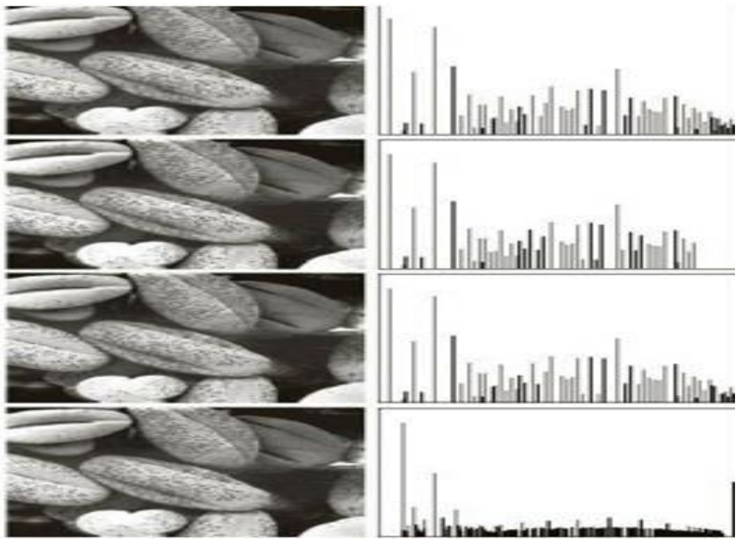


Fig 2.12 After Histogram Equalization

Fig 2.8 is Histogram of pollen grains, and fig 3.4 represents the image after histogram equalization where the graph spreads all over the plot.

2.5.3 CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION

Contrast Limited Adaptive Histogram Equalization also known as CLAHE was developed to address the problem of noise amplification. CLAHE operates on all small regions in an image known as tiles but not an entire image. Each tiles contrast is enhanced such that histogram of the output histogram approximately matches the histogram specified by the distribution parameter. The neighboring tiles are then combined using bilinear interpolation to eliminate artificially induced boundaries. The contrast especially in homogenous areas can be limited to avoid amplifying any noise that is present in an image. CLAHE was originally developed for medical imaging and has proven to be successful for enhancement of low contrast images such as portal images.

The CLAHE algorithm partitions the images into contextual regions and applies the histogram equalization to each one. This evens out the distribution of used grey values and thus makes hidden features of the image more visible. The full grey spectrum is used to express the image. Contrast Limited Adaptive Histogram Equalization, CLAHE, is an improved version of AHE, or Adaptive Histogram Equalization, both overcome the limitations of standard histogram equalization.

Sharp field edges can be maintained by selective enhancement with in the field boundaries.

Selective enhancement accomplished by first detecting the field edge in a portal image and then only processing those regions of the image that lie inside the field edge. Noise can be reduced while maintaining the high spatial frequency content of the image by applying a combination of CLAHE, median filtration. This technique known as sequential processing can be recorded into a user macro for repeat application at any time. A variation of the contrast limited technique called adaptive histogram chip (AHC) can also be applicable.

Chapter 3

METHODOLOGY

METHODOLOGY

3.1 PROPOSED IMAGE ENHANCEMENT METHOD:

Image enhancement techniques have been widely used to get a good quality of an image for the human interpretation. Image enhancement techniques are broadly classified as local image enhancement and global image enhancement.

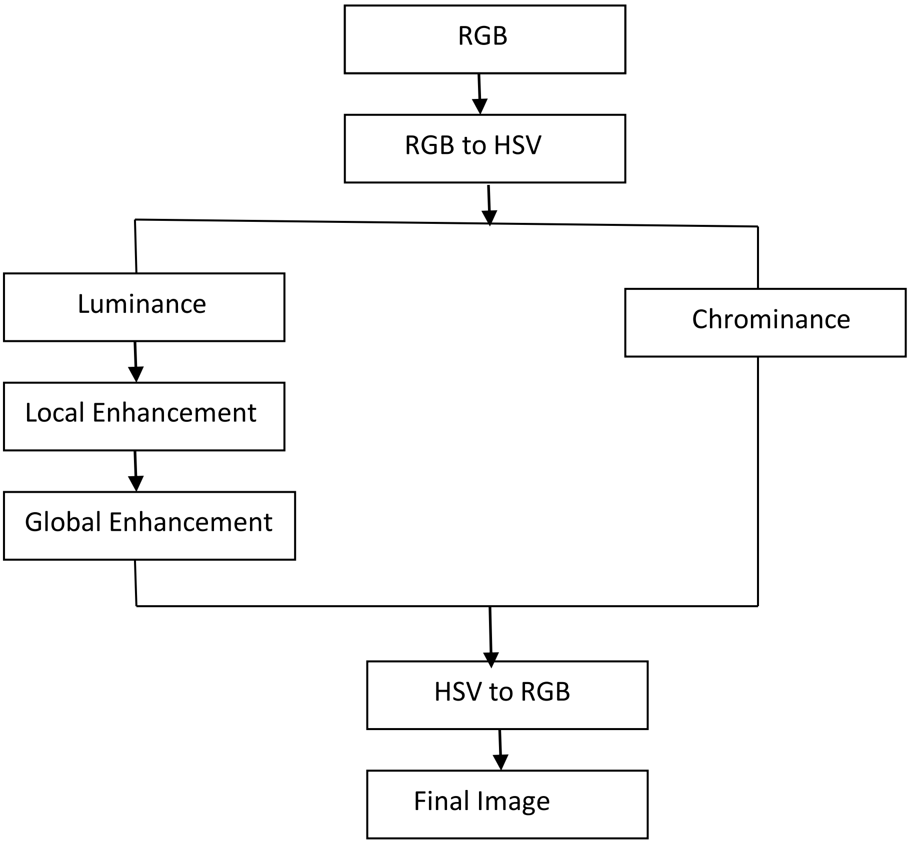


Fig: 3.1 Flow graph of proposed Image enhancement

3.2 DESCRIPTION ABOUT THE BLOCK DIAGRAM:

In this method first an image is taken and converted from the red green and blue (RGB) color space to the HSV color space. From the HSV colour space, the V component or the luminance component is taken to apply the algorithm. In order to enhance the local gradients or the local details, an existing local enhancement method has been used. Here the unsharp masking is used as local details enhancement method. As the name suggests it uses the blurred image to make the mask and enhances the local details in the form of edge sharpening. The sharpened image is used as the input to the global enhancement method. The global enhancement method uses one of the global contrast stretching methods.

At first a color image to be enhanced is taken and it is converted to the HSV color space. From that color space the luminance portion is taken. The enhancement in the hue and saturation is not done. The image enhancement is performed only in the luminance plane of the image. The local details of an image can be accessed or addressed through the luminance only. There is effect of hue and saturation also in the contrast but the effect is less compared to luminance of an image. The luminance portion is responsible for the local radiance of the image. The luminance is enhanced by applying the proposed algorithm and it is combined with the chrominance and converted back to color image.

The proposed method to be incorporated in order to get a good quality image by combining both local enhancement and global enhancement of a color image.

It mainly consists of the following four steps.

Step 1: Get the color image and convert it into hue, saturation and value (HSV) color space and take the luminance of that image.

Step 2: Apply the local enhancement method to enhance the local details of image.

Step 3: The local output is again given as global input and perform global image enhancement.

Step 4: Recombine the components and reconvert it back to color image.

3.3 LOCAL ENHANCEMENT OF AN IMAGE:

The local enhancement is employed to get the minute details of an image. It enhances the local details in terms of the gradient of the image which gives useful information to the analyser of the image. It addresses those pixels which would be ignored by the global method. The local enhancement method employed here is unsharp masking [8]. In this method the image is sharpened by subtracting an unsharp image,that is a blurred or smoothed from the original image, so the name unsharp masking is derived. In this method the following steps are involved:

1. Blurring of the image.
2. Subtracting the blurred image from the original image to make the mask.
3. Adding the mask to the original image.

3.3.1 Blurring of an image:

In blurring, we simple blur an image. An image looks more sharp or more detailed if we are able to perceive all the objects and their shapes correctly in it. For example, an image with a face, looks clear when we are able to identify eyes, ears, nose, lips, forehead e.t.c very clear. This shape of an object is due to its edges. So in blurring, we simple reduce the edge content and makes the transition form one color to the other very smooth.

Blurring can be achieved by many ways. The common type of filters that are used to perform blurring are.

- Mean filter
- Weighted average filter
- Gaussian filter

Out of these three, we are going to discuss about the mean filter.

Mean filter:

Mean filter is also known as Box filter and average filter. A mean filter has the following properties.

- It must be odd ordered
- The sum of all the elements should be 1
- All the elements should be same

If we follow this rule, then for a mask of 3x3. We get the following result.

1/9	1/9	1/9
1/9	1/9	1/9
1/9	1/9	1/9

Since it is a 3x3 mask, that means it has 9 cells. The condition that all the element sum should be equal to 1 can be achieved by dividing each value by 9. As

$$1/9 + 1/9 + 1/9 + 1/9 + 1/9 + 1/9 + 1/9 + 1/9 + 1/9 = 9/9 = 1$$

Fig: 3.3.1 Original image

Fig: 3.3.2 Blurred image

If the blurred image is denoted as b (i,j) and the image as p (i,j) then the mask m (i,j) is given according to equation .

$$m(i, j) = p(i, j) - b(i, j)$$

3.3.2 Sharpening of an image:

Sharpening enhances the definition of edges in an image. Whether your images come from a digital camera or a scanner, most images can benefit from sharpening. The degree of sharpening needed varies depending on the quality of the digital camera or scanner. Keep in mind that sharpening cannot correct a severely blurred image

Sharpen your image on a separate layer so that you can resharpen it later to output to a different medium.

If you sharpen your image on a separate layer, set the layer's blending mode to Luminosity to avoid color shifts along edges.

Sharpening increases image contrast. If you find that highlights or shadows are clipped after you sharpen, use the layer blending controls (if you sharpen a separate layer) to prevent sharpening in highlights and shadows.

Reduce image noise before sharpening so that you don't intensify the noise.

Sharpen your image multiple times in small amounts. Sharpen the first time to correct blur caused by capturing your image (scanning it or taking it with your digital camera).

After you've color corrected and sized your image, sharpen it again (or a copy of it) to add the appropriate amount of sharpening for your output medium.

If possible, judge your sharpening by outputting it to the final medium. The amount of sharpening needed varies among output media.

Fig: 3.3.3 Original image

***Fig:3.3.4* Sharpen image**

The weighted portion of the mask is added to the original image to get the sharpened image s (i,j) given by equation (2).

$$s(i, j) = p(i, j) + w * m(i, j)$$

where 'w' is the weight, generally greater than zero. When the weight is equal to 1, it is the unsharp masking and when greater than 1 then it is called high boost filtering. This sharpened image is given as input to the global contrast enhancement process for further improvement in the image quality or to improve the visual quality of the image.

3.4 GLOBAL ENHANCEMENT OF AN IMAGE:

The global enhancement of the image is used to increase the contrast of the image. In this process each pixel of the image is adjusted so that it gives a better visualization of the image. In spatial contrast enhancement, the operation is performed directly on the pixel. The pixels are arranged in such a way that it is distributed throughout the range of desired intensity level. Global contrast stretching method is used as global method of enhancing the image. There are many global techniques like histogram equalization (HE), contrast limited adaptive histogram equalization and many other transformation methods like discrete cosine transform (DCT), discrete shearlet transform (DST), adaptive inverse hyperbolic tangent function transformation, etc.

3.4.1 Histogram Equalization:

Among these, HE is the one used widely as global method. Any of the method can be used to enhance the image globally. In all the global methods they did not consider the local details of the image and look for the global information of the image. So we first apply the local enhancement in order to verify the algorithm, the simple HE is used. It is not mandatory to use only this method ,different methods can be used to improve the image quality.

For the discrete image, the probabilities of the pixel value is taken in HE. To take the probabilities, first the corresponding number of pixels should have particular pixel intensity value, it is calculated and divided by the total number of the pixels present in the image. The probability of occurrence of pixel intensity level ‘k’ in the digital image is stated by equation

$$\mathrm{p}(\mathrm{r}_{\mathrm{k}}) = \frac{nk}{N*M}$$

Where N*M is the total number of pixels in the image and nkisthe total number of pixels having intensity level ”k”. The pixel sare transformed according to the following transformation equation in discrete form [8].

$$t_{k=L(r_k)=(G-1)\sum_{i=0}^{k} p(r_i) =\frac{G-1}{N*M}\sum_{i=0}^{k} n_i}$$

where ‘G’ is the highest intensity level or value, L (rk) is the transform function and k = 0, 1, 2, 3, ..., G-1. So the output image pixel is obtained by mapping each input pixel ri to the new transformed value tk. The processed output value may have fractional value so a rounding function to the nearest integer value is needed. While doing so some of the image pixels may go to the new value and some of the intensity pixel values may not be present in the transformed image.

Fig: 3.4.1 Input image

Fig: 3.4.2 Output image

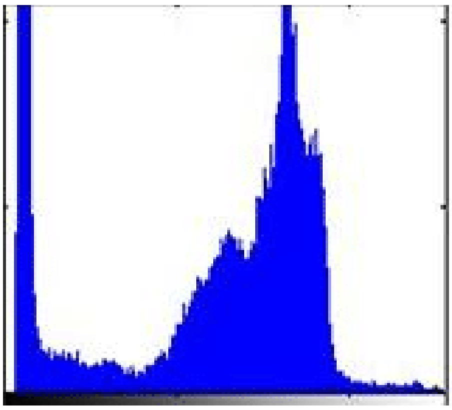


Fig: 3.4.3 Input histogram

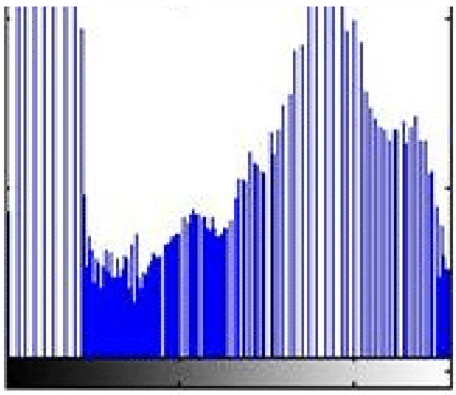


Fig: 3.4.4 Output histogram

Chapter 4

RESULTS

4.1 SOFTWARE DESCRIPTION:

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN.MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science.

MATLAB features a family of add-on application-specific solutions called toolboxes, very important to most users of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

4.1.1 THE MATLAB LANGUAGE:

This is a high-level matrix/array language with control flow statements, functions, data structures, input/output, and object-oriented programming features. It allows both "programming in the small" to rapidly create quick and dirty throw-away programs, and "programming in the large" to create complete large and complex application programs.

4.1.2 GRAPHICS:

MATLAB has extensive facilities for displaying vectors and matrices as graphs, as well as annotating and printing these graphs. It includes high-level functions for two-dimensional and three-dimensional data visualization, image processing, animation, and presentation graphics. It also includes low-level functions that allow you to fully customize the appearance of graphics as well as to build complete graphical user interfaces on your MATLAB applications.

4.1.3 USING THE MATLAB EDITOR TO CREATE M-FILES:

The MATLAB editor is both a text editor specialized for creating M-files and a graphical MATLAB debugger. The editor can appear in a window by itself, or it can be a sub window in the desktop. M-files are denoted by the extension .m, as in pixel up m. The MATLAB editor window has numerous pull-down menus for tasks such as saving, viewing, and debugging files. Because it performs some simple checks and also uses color to differentiate between various elements of code, this text editor is recommended as the tool of choice for writing and editing M-functions. To open the editor, type edit at the prompt opens the M-file filename m in an editor window, ready for editing. As noted earlier, the file must be in the current directory, or in a directory in the search path.

4.1.4 GETTING HELP:

The principal way to get help online is to use the MATLAB help browser, opened as a separate window either by clicking on the question mark symbol (?) on the desktop toolbar, or by typing help browser at the prompt in the command window. The help Browser is a web browser integrated into the MATLAB desktop that displays a Hypertext Markup Language (HTML) documents.

4.1.5 MATLAB DESKTOP:

MATLAB Desktop is the main MATLAB application window. The desktop contains five sub windows, the command window, the workspace browser, the current directory window, the command history window, and one or more figure windows, which are shown only when the user displays a graphic.

The command window is where the user types MATLAB commands and expressions at the prompt (>>) and where the output of those commands is displayed. MATLAB defines the workspace as the set of variables that the user creates in a work session. The workspace browser shows these variables and some information about them. Double clicking on a variable in the workspace browser launches the Array Editor, which can be used to obtain information and income instances edit certain properties of the variable.

4.2 STANDARD DEVIATION:

The standard deviation is a measure used to quantify the amount of variation or dispersion of a set of data values standard deviation close to zero indicates that the mean of the set while a high standard deviation indicates that the data points are spread over wider range of values.

A large standard deviation indicates that the data points can spread far from the mean and a small standard deviation indicates that they are clustered closely around the mean. The practical value of understanding the standard deviation of a set of values is in appreciating how much variation there is from the mean.

Related to our project the standard deviation is more when the dynamic ranges in histogram is more. Normally for a good image the dynamic ranges should spread over the histogram. To know how much the image is enhanced we use standard deviation as a metric. The reason why only standard deviation is used is the difference of pixel to pixel value can be taken only in standard deviation than all other metrics present.

A standard deviation filter calculates the standard deviation and assigns this value to the center pixel in the output map. As it has capability in measuring the variability, it can be used in edge sharpening, as intensity level get changes at the edge of image by large value.

Standard deviation filters can be useful for radar images. The interpretation of radar images is often difficult: you cannot rely on spectral values because of back scatter (return of the pulse sent by the radar). This often causes a lot of 'noise'. By using a standard deviation filter, you may be able to recognize some patterns.

While the final arbiter of image quality is the human viewer, efforts have been made to create objective measurements of quality. This can be useful for many applications. Many objective measures of quality require the existence of a distortion-free copy of an image, called the reference image that can be used for comparison with the image whose quality is to be measured. The dimensions of the reference image matrix and the dimensions of the degraded image matrix must be identical.

4.3 RESULTS:

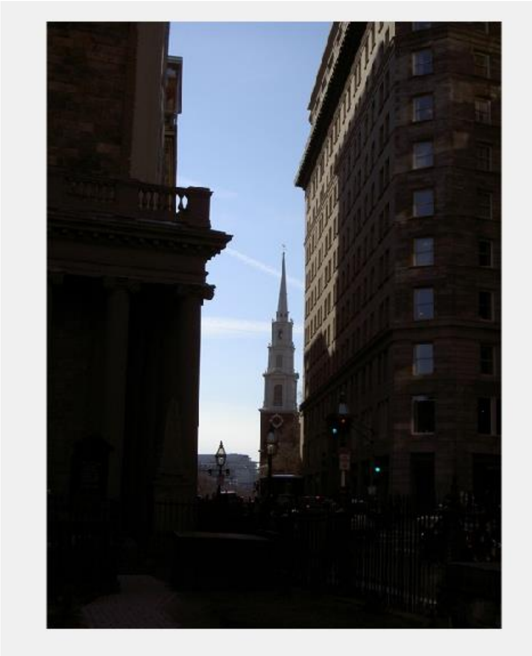


Fig: 4.3.1 Input image 1

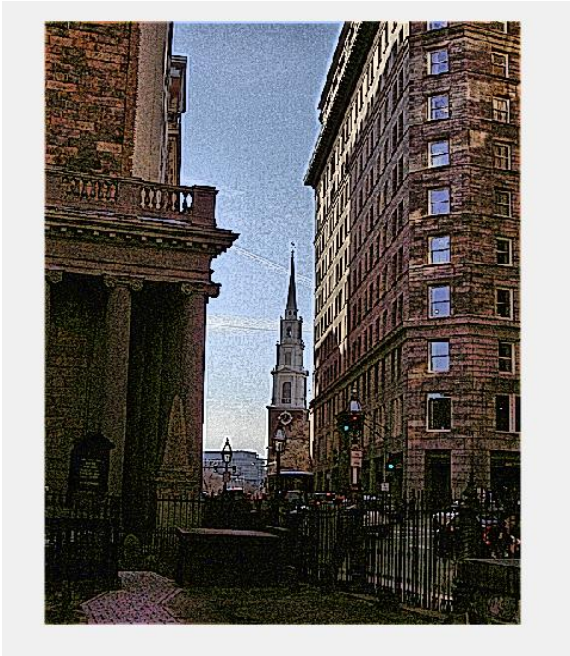


Fig: 4.3.2 Enhanced image 1

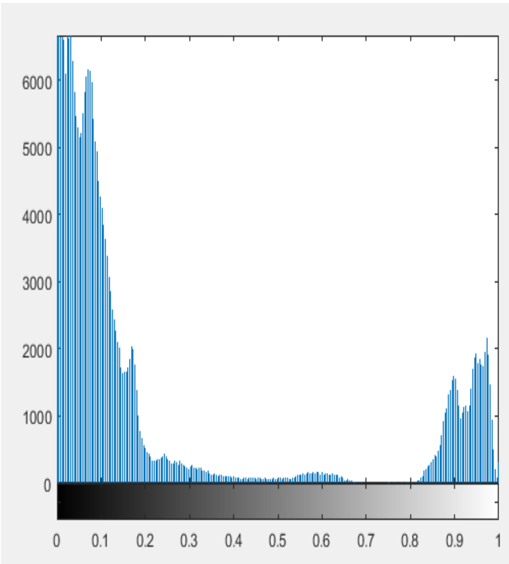


Fig: 4.3.3 Input Histogram 1

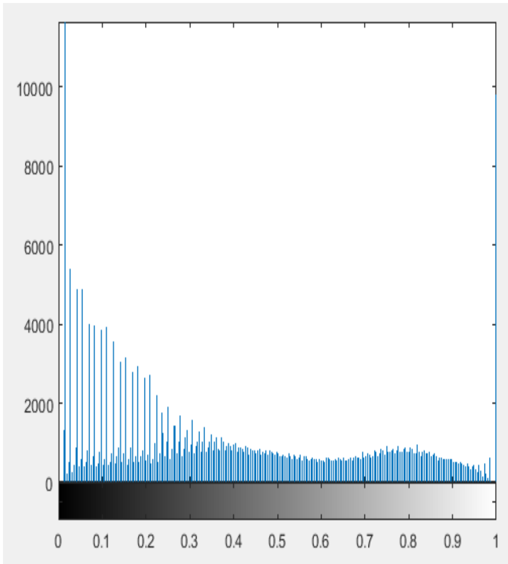


Fig: 4.3.4 Output Histogram 1

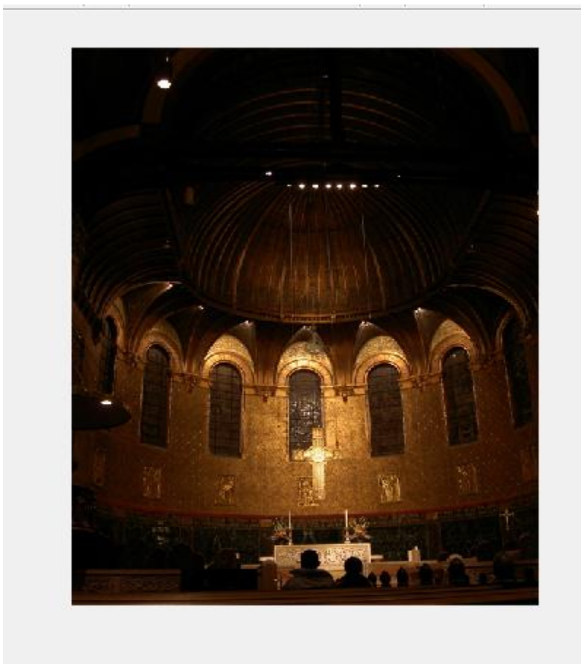


Fig: 4.4.1 Input image 2

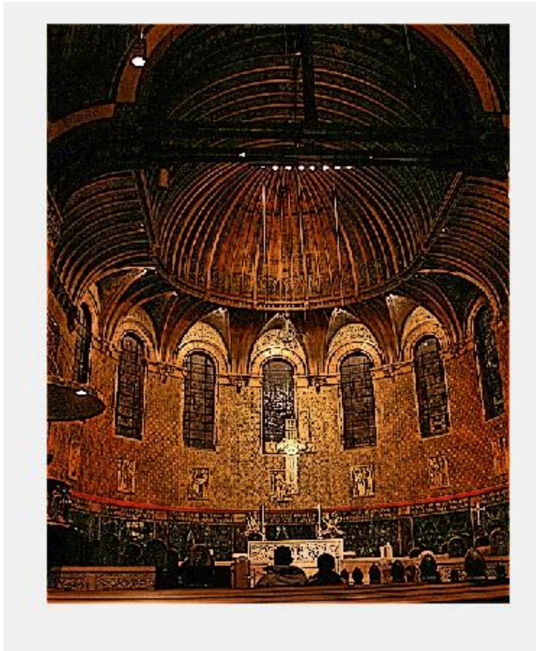


Fig: 4.4.2 Enhanced image 2

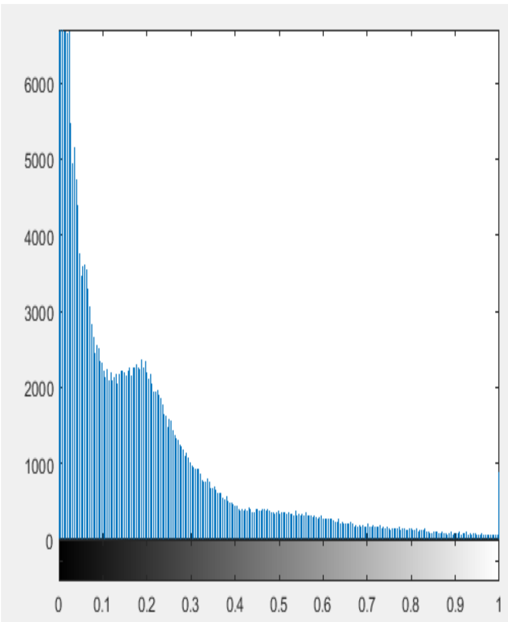


Fig: 4.4.3 Input Histogram 2

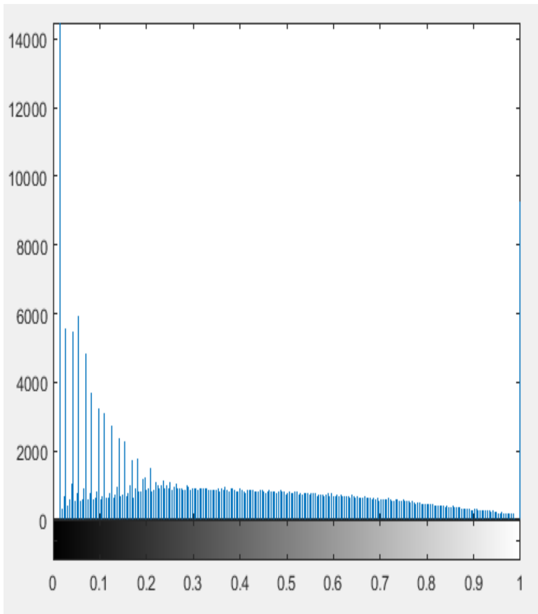
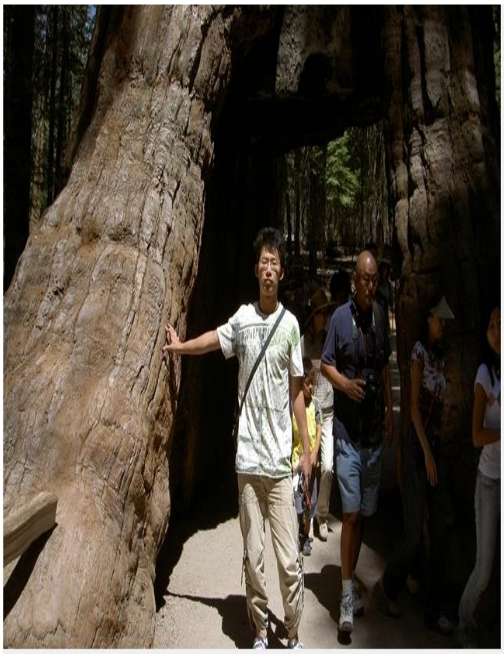


Fig: 4.4.4 Output Histogram 2



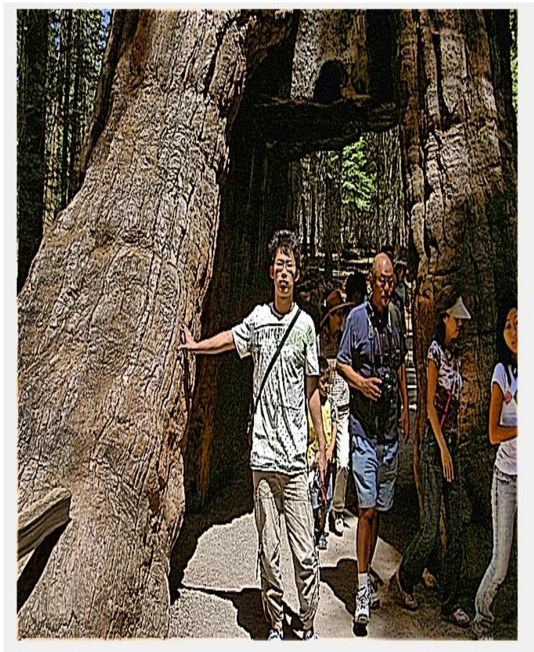
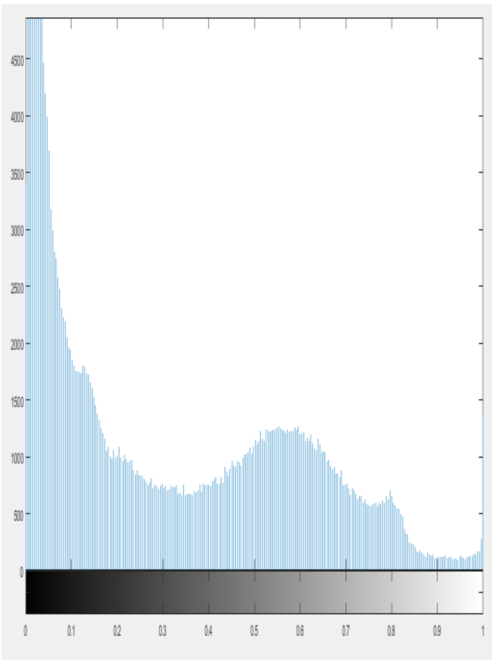


Fig: 4.5.1 Input image 3

Fig: 4.5.2 Enhanced image 3



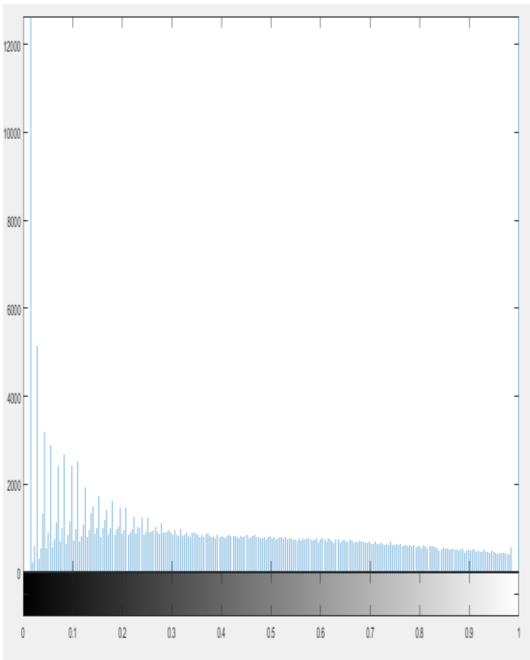


Fig: 4.5.3 Input Histogram 3

Fig: 4.5.4 Output Histogram 3

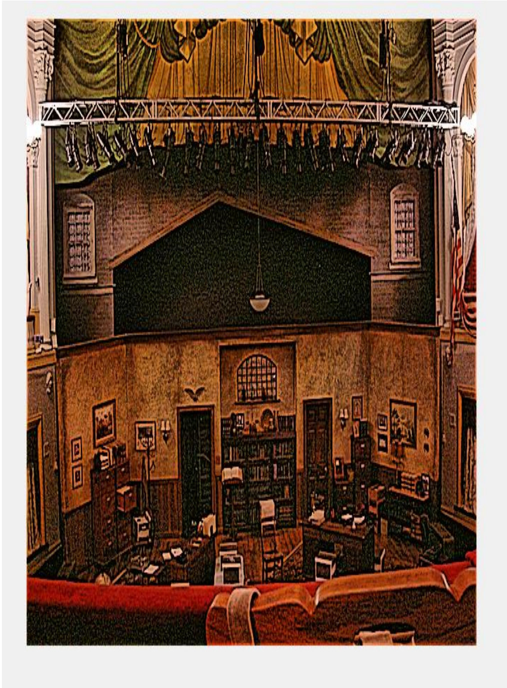
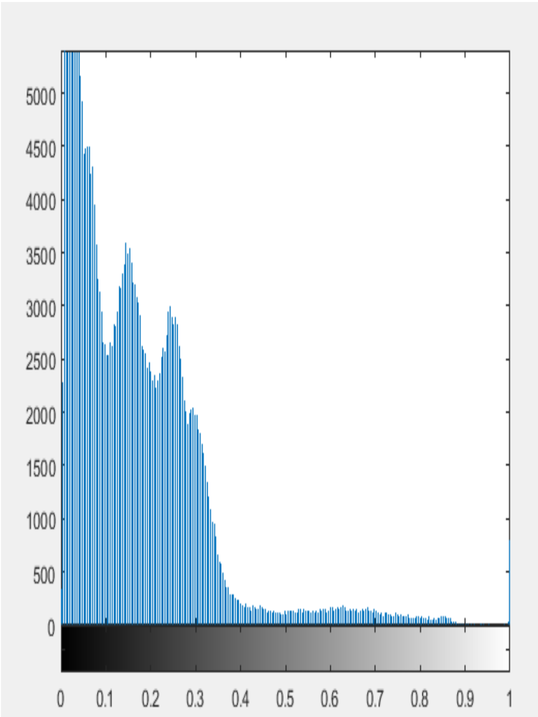


Fig: 4.4.1 Input image 4

Fig: 4.4.2 Enhanced image 4



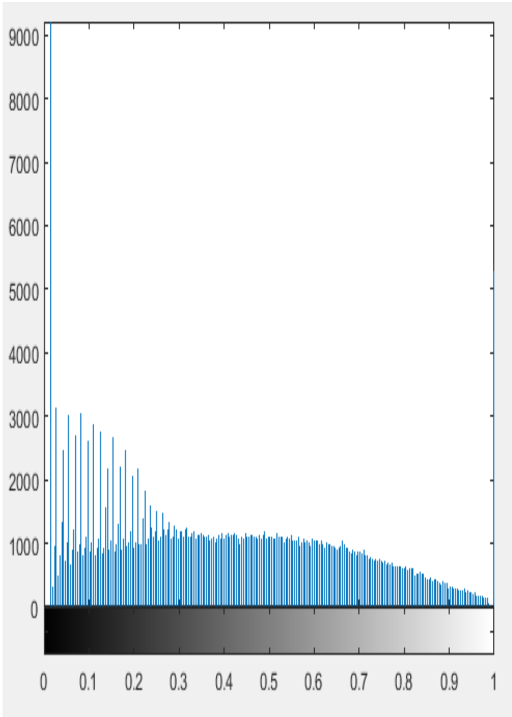


Fig: 4.5.3 Input Histogram 4

Fig: 4.5.4 Output Histogram 4

CALCULATIONS OF AN IMAGE IN TABULAR FORMAT:

IMAGE	INPUT MEAN	OUTPUT MEAN	INPUT VARIANCE	OUTPUT VARIANCE
1. IMAGE 1	0.2932	0.3308	0.0921	0.0987
2. IMAGE 2	0.3483	0.3894	0.1414	0.0891
3. IMAGE 3	0.3080	0.3336	0.0869	0.1149
4. IMAGE 4	0.3304	0.3898	0.1085	0.0801

Chapter 5

CONCLUSION AND FUTURE SCOPE

CONCLUSION AND FUTURE SCOPE

CONCLUSION:

We have presented a simple and efficient algorithm for automatic image enhancement and tested it on some images. The method works well for cases in which the foreground and background peaks are not well-separated, i.e., the input image is of a low contrast. The method is successfully carried out in MATLAB. Combination of both local and global contrast enhancement techniques are employed to improve the visual quality of an image, where a local enhancement method is applied first to enhance the local details of the image, which is not taken care and usually neglected in the global contrast enhancement. The locally enhanced image is given to the input of global enhancement for better visual perceptions and increases the brightness to a level which gives pleasant sensation to the human eye. This method works fine in most of the dark images. It has more significance to those images where we need local minute gradient information such as the image of planetary and heavenly bodies, satellite images and medical images. The comparison is done with a couple of the existing methods. The different local and global methods have been used and tested their effectiveness of the different combinations of the local and global methods.

FUTURE SCOPE:

The research may be extended to apply the proposed approaches for medical imaging, content based image retrieval and other areas of computer vision applications where texture plays a major role.

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