FACE BEAUTIFICATION

Dissertation submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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DECLARATION BY THE SCHOLAR

We hereby declare that the work reported in the B-Tech thesis entitled **"Face Beautification"** submitted at **Jaypee University of Information Technology, Waknaghat India,** is an authentic record of our work carried out under the supervision of **Ms. Pragya Gupta (Asst. Professor of ECE department)**. We have not submitted this work elsewhere for any other degree or diploma.

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1st May 2017

SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the M-Tech. thesis entitled "**Face Beautification**", submitted by **Drishti Khampa, Damini Jaiswal and Akshita Mahajan** at **Jaypee University of Information Technology, Waknaghat**, **India,** is a bonafide record of their original work carried out under my supervision. This work has not been submitted elsewhere for any other degree or diploma.

Ms. Pragya Gupta

Jaypee University of Information Technology

1st May 2017

ACKNOWLEDGEMENT

We are very fortunate to have got all help and support from many people in the completion of our project. We would not forget to thank all of them.

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Especially, we would like to give our special thanks to our parents whose love enabled us to complete this work. And at last but not the least we would like to thank God for the successful completion of our project.

LIST OF ACRONYMS AND ABBREVIATIONS

DIP	Digital Image Processing
EMW	Electromagnetic Wave
FFT	Fast Fourier Transform
GIF	Graphics Interchange Format
IFT	Inverse Fourier Transform
JPEG	Joint Photographic Experts Group
LSB	Least Significant Bit
MPEG	Moving Pictures Experts Group
MSB	Most Significant Bit
PDF	Portable Document Format
PDF	Probability Distribution Function
RGB	Red Green Blue
2-D	Two-dimensional

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ABSTRACT

In this project, we propose a unified facial beautification framework with respect to skin uniformity, lightning, and color. In this we are trying to enhance the facial features like removal of pimples, black spots, teeth whitening, color enhancement without affecting the quality of image of other parts of the face. We have done various color conversions such as color to gray, gray to binary, gray to color, etc. and also determined various edge detection techniques. We have created new algorithms to work on a specific part of an image without interfering the other parts of the face. In our framework, an image has been smoothened by preserving the edges of other parts of an image. Our method gives more flexible and appropriate skin enhancement techniques.

The experimental outputs illustrate that our methods are different from previous methods and are comparable to commercial world. We have compared our final results with the previously designed algorithms like filters to enhance facial beautification, facial apps. The results also show that the proposed methods have the ability to beautify the face.

CHAPTER 1

LITERATURE REVIEW

Preview

Image processing is a technique to perform some of the operations on an image. With the help of this method we get an upgraded image and also we can be able to extract some useful data from it. In this type of processing, image will be taken as input and output will also be an image. Nowadays image processing is rapidly growing technology. It has become core research area in engineering and computer science streams too.

1.1 Purpose of Image processing

This can be classified into five groups and they are:

1. Measurement of pattern – It measures various objects in image.
2. Image retrieval – It seeks for image of interest.
3. Image restoration and sharpening- It creates a better image.
4. Image Recognition – It distinguishes objects in an image.
5. Visualization – It observes the objects which are not visible.

In image processing, there are two types of methods- one is analogue image processing and the other one is digital. Analogue image processing is used for the hard copies like photographs and printouts. Different fundamentals of image were found while using these techniques. Digital processing method manipulates digital images by using algorithms. All types of information undergo different techniques of digital processing such as segmenting and enhancing the image, pre-processing and information extracting from an image.

In this chapter we will talk about few fundamental definitions such as image, digital image, and digital image processing. Different sources of any digital image will be discussed later and examples for every source will be provided. Finally we will be going to talk about image acquisition.

1.2 Digital Image

Any digital image is a two dimensional image having finite set of digital values, which is called picture elements or we can say it as pixels. See Figure 1.1.

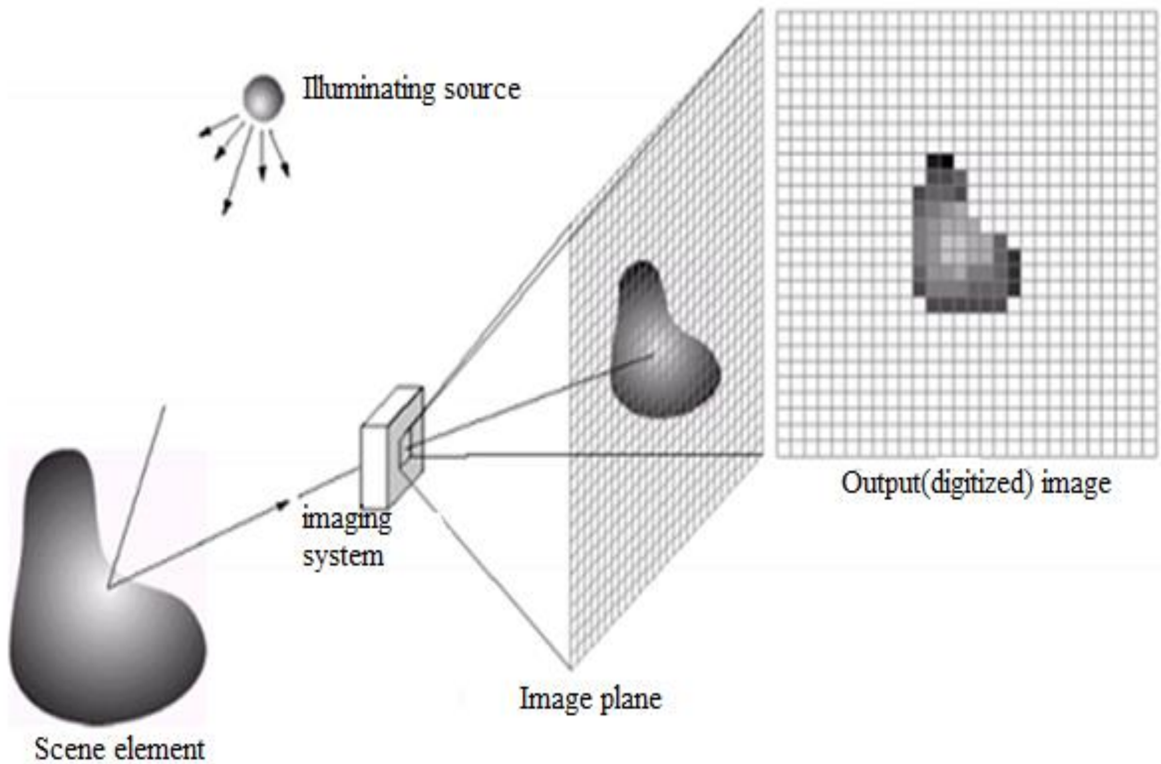

Figure 1.1: Formation of digital image

Pixel values represent gray levels, heights, colors, opacities etc. Digitization of an image implies that digital image is an approximation of any real scene. See Figure 1.2.

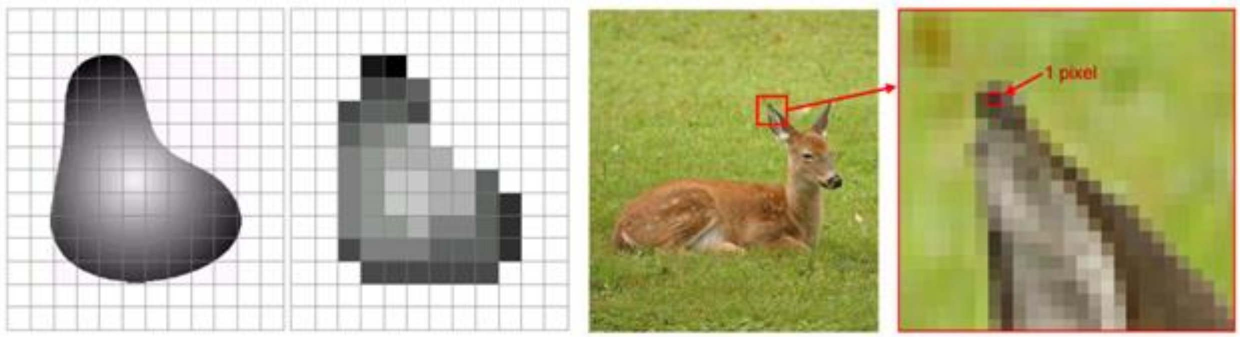

Figure 1.2: Pixels in digital image

Common image formats include -

1. Black and white or Grayscale
2. Red, Green, Blue, and Alpha
3. Red, Green, and Blue (RGB)

(a) (b)(c)

Figure 1.3: Format of image**(a)**Black and white image, **(b)** Red, Green, and Blue image **(c)** Red, Green, Blue, and Alpha

Here we will focus on gray-scale and RGB images.

1.2.1 Digital Image Processing

In digital image processing we use computer algorithm to perform image processing on any digital image. Digital image processing has various advantages over analogue image processing. It enables a much wider range of algorithms which can be applied to any input data and also can avoid problems such as signal distortion and build up of noise during processing. As images are two dimensional digital images, it can be formulated in the form of multidimensional image.

Digital image processing deals with manipulation of digital image through digital system. In general it focuses on images rather than signal and system.

1.2.2 Two major tasks in digital image processing

- Improving pixel information for understanding of human
- Processing image for storing data, representing and transmitting autonomous machine perception

1.3 Steps in digital image processing

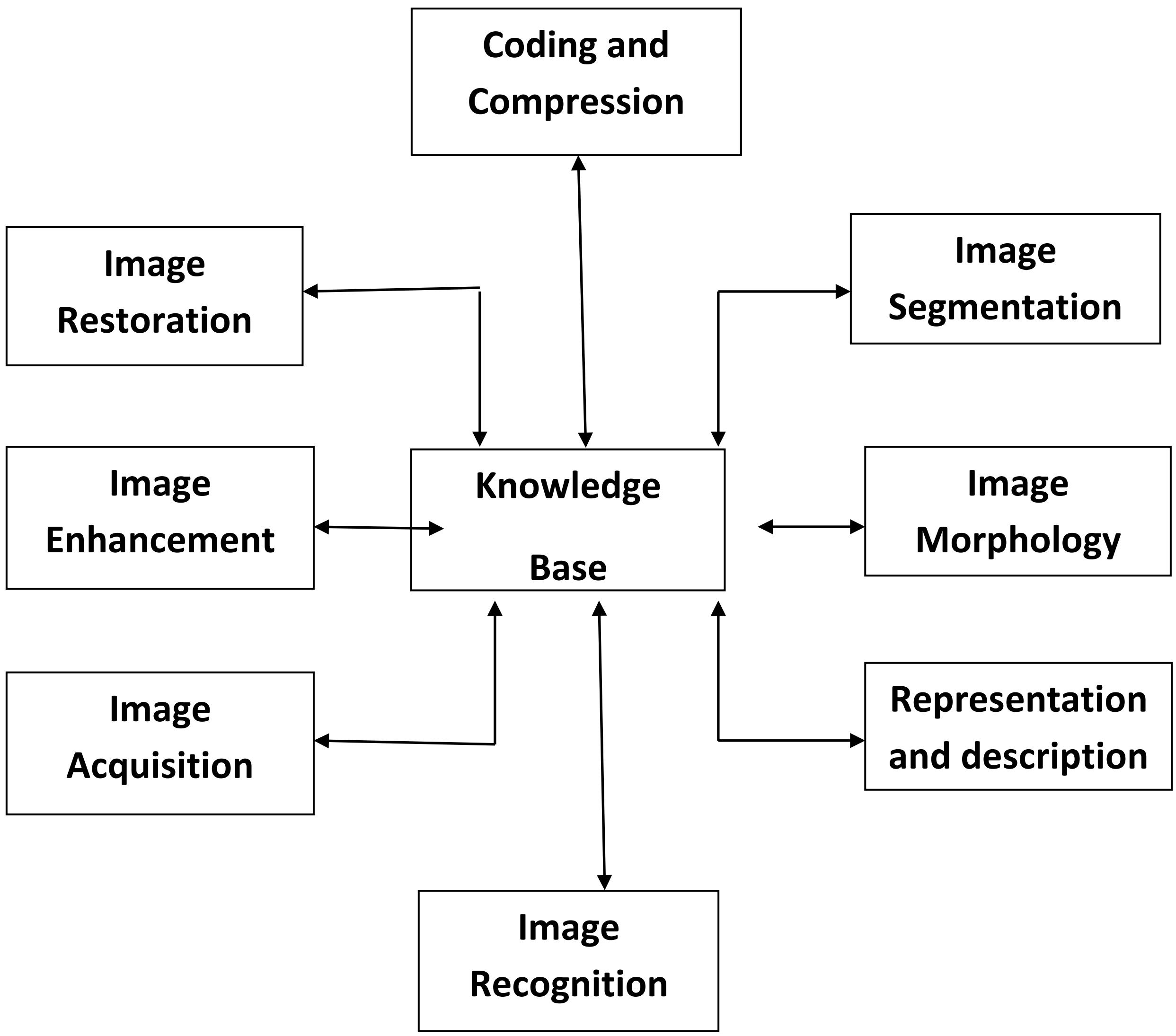

Figure 1.4: Steps in digital image processing

Three levels of Processing of DIP

(a) **Low level processing –** In this input and output of processing is an image.
(b) **Mid level processing –** In this input of processing system is an image and output is object or element of an image.
(c) **High level processing –** In this input and output of processing is element of an image. For example – finger print recognition.

1.3.1 Image Acquisition

It is the action of retrieving an image from any source, which is usually a hardware-based source. Performing image acquisition is always the first step in workflow sequence as without an image, no processing is possible.

Image acquisition uses optical sensor system to transform electromagnetic (EM) radiation into voltage wave. For analysis of this 2-D voltage waveform we do sampling and quantization of the signal.

1.3.2 Image Enhancement

It is the method used to improve the quality of stored digital image by manipulating image digitally. It is very easy to make an image darker or lighter, or to decrease or increase the contrast. Image enhancement software supports many filters which can alter images in various ways.

It improves visual quality of an image so that output image is better than original image. It is a subjective process and it depends on the feeling of person like increasing or decreasing brightness or removing noise, blurring, smoothening etc.

Image enhancement techniques are divided into two categories:

1. Spatial domain methods that operate directly on pixel values
2. Frequency domain methods that operate on the Fourier transform (FT) of image.

1.3.3 Image Restoration

Image restoration is the action of taking a corrupt image and finding the original and clean image. Corruption can occur in various ways like mis-focus of camera, noise and motion blur. Image restoration can be performed by reversing those processes that has blurred the image and this can be performed by imaging point source and use that point source image, which is known as Point Spread Function to restore the information of an image lost in the blurring process. The main objective of image restoration techniques is to recover and regain resolution loss, to reduce noise and to maintain its quality. Image processing methods are implemented either in the space domain or the frequency domain.

It improves visual quality of an image but in this we must have prior information about degradation phenomenon of an image. Image restoration is low – level processing technique.

1.3.4 Coding and Compression

The output of coding is another representation of an image.

Compression is a technique in which we have to find the correlated data in 2 – D array. As correlated data are redundant, hence it needs to be compressed as there is no need to send same data again and again.

Coding and Compression is a low – level processing technique.

Some of the compression standards are –

.jpg	JPEG (Joint Photographic Experts Group)
.tif	TIFF (Tagged Image File Format)
.gif	GIF (Graphics Interchange Format)
.pdf	PDF (Portable Document Format)
.mp3/.mp4	MPEG (Moving Pictures Experts Group)

1.3.5Image Segmentation

It is the process that partitions an image into different parts or objects. Segmentation basically focuses on simplifying and also it helps in changing representation of image into something which has more meaning and much easier to examine.

1.3.6 Image Morphology

Image morphology is a technique that processes images based on shapes. Morphological operation applies structuring element to input image that creates an output image of the same size. After dividing an image using image segmentation technique, we can extract that part of an image which is desired or extract the object from image with the help of image morphology.

1.3.7 Image Representation and Description

The output of segmentation and morphology is a 2 – D matrix of data. We do not know anything about this matrix, so using image representation technique we can find the boundaries and texture of an image.

Two types of representation schemes are:

External Representation – We use this representation technique when only shape of an object is important.

Internal Representation – We use this representation technique when we are interested in regional properties of objects.

Description or feature selection is a technique in which boundaries are described by concavity of segment. With the help of this we can detect the shape of boundaries and hence we can describe an object.

It is a high – level processing technique.

1.3.8 Object Recognition

Object Recognition is a method to identify any specific object in digital image or video. Algorithms for object recognition rely on learning, matching or pattern recognition algorithms that use feature-based or appearance-based techniques. It helps in recognizing the object we have extracted from an image.

Object recognition is a high – level processing.

Color Image Processing

A color image is a digital image which includes information about color for each and every pixel. With this method processing can be done at any particular part of colored image.

CHAPTER 2

EDGE DETECTION

Preview

Edge detection includes different varieties of mathematical approaches that aim at detecting points in a digital image at which the brightness of an image changes sharply or has discontinuities. Those points at which image brightness has discontinuities in pixel values they are organized into a set of curved line segments termed edges. This is used for segmentation and data extraction in areas such as computer vision, machine vision and image processing.

2.1 Canny edge detector

It is an edge detection approach which uses an algorithm to detect the edges in images.

2.1.1Algorithm

- Use Gaussian filter to blur the image.
- Find horizontal and vertical gradients.
- Then compute magnitude and direction of gradient.
- Perform Non-Maximal Suppression.
- Perform Hysteresis Threshold.

2.1.2 Gaussian Filter

For smoothening of an image, Gaussian filter is convolved with an image. This step will lightly smooth the image and reduces the effects of noise on an edge detector. The equation for a Gaussian filter is

$$G(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}}$$

2.1.3 Finding intensity gradient of an image

Edge in the image may point in different directions, that is why Canny algorithm uses filters to detect diagonal, horizontal and vertical edges in the blurred image. It gives results for the first derivative in both the vertical direction (G_y) and the horizontal direction (G_x).From this the direction and edge gradient can be determined as

$$G = \sqrt{G(x)^2 + G(y)^2}$$

$$\Theta = \operatorname{atan2}(G_y, G_x)$$

2.1.4 Non-maximum suppression

Edge thinning technique is known as non-maximum suppression.

Non-Maximum suppression is used to thin the edge. After gradient calculation, edge extracted from gradient value is still blurred. With respect to step 3, there should be one accurate response for an edge. Thus non-maximum suppression may help to suppress all gradient values to zero except local maxima that indicate location with sharp change in intensity value. The algorithm for non-maximum suppression is:

1. Compare edge strength of current pixel with edge strength of a pixel in the negative and positive gradient directions.
2. If edge strength of current pixel is largest compared to other pixels in mask with same direction (i.e., pixel that is pointing in the x direction will be compared to pixel left and right in the horizontal axis), the value will be preserved. Otherwise that value will be suppressed.

2.1.5 Double threshold

After non-maximum suppression, edge pixels of an output image are very accurate in presenting the real edge. But there are still some of the edge pixels at this point caused by color variation and noise. To get rid of the false responses from these factors, it is necessary to filter out these edge pixels with weak gradient values and preserve the edges with the high gradient values. Thus we need two threshold values which are set to clarify the different types of edge pixels in an image, one is called low threshold value and the other is called the high threshold value. If the gradient value of edge pixels is higher than high threshold value, they are remarked as strong edge pixels. If the gradient value of edge pixels is smaller than high threshold value and larger than low threshold value, they are remarked as weak edge pixels.

2.1.6 Edge tracking through hysteresis

By suppressing all the edges that are weak and not connected to strong edges we can finalize the detection of edges. The weak edges should be removed to achieve accurate result. A weak edge pixel caused from true edges will be connected usually to a strong edge pixel while noise responses are not connected.

2.2 Laplacian edge detector

- Take sample of any image.
- Blur that image. Since we want to select edges, we don't need each and every edge in that image, only the main features are required. Hence we need to blur the image for the purpose of edge detection.
- Convolve this image with Gaussian filter. Here a Gaussian filter is used to smooth an image as it is a low pass filter having ripples and these ripples show up as edges.
- Now use Laplacian filter on this blurred image.
- Then find zero-crossing.

- Finally use Median Filter. Here we have applied a median filter as it removes all the spot noise and preserve the edges. This will yield a clear representation of the edges of original image.

Let us understand it with the help of an example:

Take the following signal, having an edge as highlighted below in Figure 2.4:

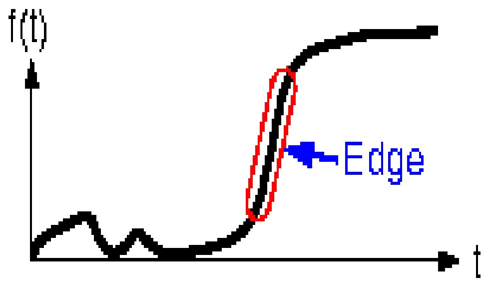

Figure 2.1: Sample signal for laplacian edge detection

Take the gradient of this above signal (which, in 1-D, is just first derivative with respect to t) we get following signal

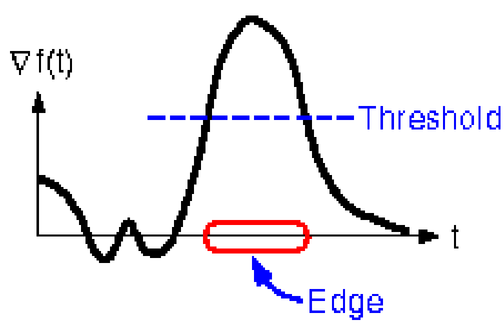

Figure 2.2: Gradient of signal

As we can see, gradient has larger peak centered around edge. We can detect any edge whenever the threshold is exceeded, by comparing gradient to the threshold as shown above. In this, we have found edge, but this edge has become thick due to the thresholding technique. As the edge only occurs at the peak, so we can localize it by evaluating the Laplacian and finding zero crossings.

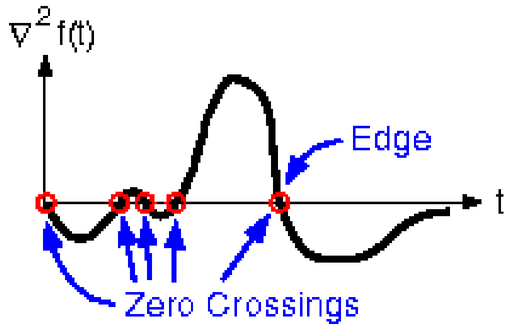

Figure 2.3: Zero Crossings of signal

The above figure shows laplacian of our 1-D signal. As expected, here also the edge corresponds to zero crossing, but we can also see another zero crossings that may correspond to some smaller ripples in the original signal.

Now find zero crossings of the Laplacian and compare local variance at every point to a particular threshold. Then declare an edge where threshold value is exceeded. And lastly, use Median Filter in the image. Here we have applied a median filter as it removes all the spot noise and preserve the edges. This will yield a clear representation of the edges of original image.

2.3 Sobel Edge Detector

- It precedes edges at all those points wherever the gradient is highest.
- It then convolves the image with separable and small filter in the vertical and horizontal directions.
- In terms of computations it is inexpensive. This Sobel–Feldman operator works on convolving any image with separable, small and integer-valued filter in the vertical and horizontal directions and therefore in terms of computations it is relatively inexpensive.

2.3.1 Sobel Algorithm

- Take the input image
- Now convolve it with separable and small filter.Then calculate approximations of the derivatives– one for vertical changes, and other for horizontal changes. And then find G_y and G_x of input image. Here G_y and G_x are two images which at each point contain the vertical and horizontal derivative approximations respectively.
- Results are combined to find the magnitude of the gradient:

$$G = \sqrt{G(x)^2 + G(y)^2}$$

$$\Theta = \mathrm{atan2}(G_y, G_x)$$

- This absolute magnitude gives the output edges

2.4 Comparison between three Methods

Table 2.1: Comparison between all three methods of edge detection

Canny	Laplacian	Sobel
1. More accurate output	Very less accurate output	Less accurate output
2. Low error rate	Very high error rate	High error rate

2.5 Image Segmentation

Using three methods we have detected edges of image and they are- Sobel edge detection, Laplacian edge detection, Canny edge detection. We have applied all these algorithms to the same image and also compared their results. After doing this we have found that among these three methods canny edge detection method gives us best result. For segmenting the image into different parts so that we are able to work on any specific parts of an image we will going to use Image Segmentation.

Image segmentation is a process of dividing any digital image into multiple segments (or sets of pixels, which are also known as super pixels). Segmentation basically focuses on simplifying and also it helps in changing representation of image into something which has more meaning and much easier to examine. This process is generally used to locate different objects and boundaries (like curves, lines etc.) in images. More precisely, image segmentation is the method in which we put a label on each and every pixel in image so that pixels with same label share same properties. A good segmentation is basically one in which -

• pixels in same category have similar grayscale with multivariate values and also form a connected region

• neighbouring pixels present in different categories have dissimilar values.

Segmentation is one of the critical step in image analysis. If segmentation is done properly then all stages in image analysis can be made simpler.

Application

- Face Detection and Recognition
- Medical Imaging
    1. Diagnosis
    2. Surgery planning

3. Locate tumors

- Finger Print Recognition
- Video Surveillance

Conclusion

Different edge detection techniques introduced in this chapter provides us with various set of tools from which we can get edges of an image. From all the above three methods discussed in the chapter, it has been found that Canny edge detection method is comparatively better than the others. It enhances all edges very well.

Edge Detection methods are helpful when there is a need to remove some unwanted parts from an image.

CHAPTER 3

COLOR IMAGE PROCESSING

Preview

RGB image has three channels- red, green, and blue. If RGB image is of 24-bit then each channel has 8 bits for red, green, and blue- or we can say that the image is made up of three images one for each channel, where every image is able to store discrete pixels having conventional brightness intensities ranging between 0 and 255. If any RGB image is 48-bit (i.e. very high color depth) then each channel is made up of 16-bit images.

G**rayscale** image is basically the one in which colors are only the shades of gray. Reason for differentiating these images from any other color image is that very less information needs to be provided for each and every pixel. In fact a gray color is the color in which red, green and blue components- all have equal intensity in RGB space and so it is only required to specify a single intensity value for every pixel, as opposed to three intensities in which we need to specify every pixel in full color image.

B**inary** image is a digital image having two possible values for each and every pixel. Basically, two colors used in a binary image are black and white, although any two colors can be used. The color used for representing objects in an image is foreground color and rest of the image is background color. Binary images can also be called two-level or bi-level. It means that every pixel is stored as a single bit- i.e. as 0 or 1. Binary images mostly arise in digital image processing as some masks or as the result of specific operations such as thresholding, segmentation and dithering. Some of the input/output devices like fax machines, laser printers and bi-level computer displays can only handle bi-level images.

3.1 Rgb to gray:

Grayscale digital image is an image, in which the value of each and every pixel is a single valued, i.e., it carries information about intensity. Images of this type, also called black and white, are made exclusively of various shades of gray, varying from white at the strongest intensity to black at the weakest.

Grayscale images have various shades of gray in between Grayscale images are the result of measuring light intensity at each and every pixel in a single band of the electromagnetic spectrum e.g. ultraviolet, visible light, infrared, etc.

To convert a color image into a grayscale image there are two methods. Both the methods have their own merits and demerits. These methods are:

- Average method
- Weighted method (luminosity method)

3.1.1 Average method

Average method is the simplest one. In this method just take the average of three colors. Since it is an RGB image, it means that we need to add r with g with b and then divide it by 3 to get desired grayscale image.

It is done in this way:

$$\text{Grayscale} = (R + G + B) / 3$$

For example:

Figure 3.1: Original Image for average method

If we have a color image like image shown above and we want to convert it into grayscale image using average method. The following result will appear

Figure 3.2: Average method grayscale Image

Justification

There is one thing to make sure, that something has happened to the original image. It means that our average method has worked. But as we can see that the results are not as expected. We wanted to convert an image into a grayscale, but rather this turned out to be a black image.

Problem

This problem arises due to the fact that we have taken the average of three colors. As three different colors i.e. red, green, blue have three different frequencies or we can say wavelengths and have their own contribution in any particular image, so take average as per their contribution. Right now this has been done as-

33.33% of Red, 33.33% of Green, 33.33% of Blue

We are taking 33.33% contribution of each color which means that each of these portions has same contribution in image. But in reality the case is different. For this problem the solution has been given by weighted average method.

3.1.2 Weighted average method

We have considered all problems which have occurred in the average method. Weighted average method has one of the solutions to this problem. As red color has highest wavelengths among all the three colors i.e. RGB and green is the color which has not only less wavelength then red color but also it is the color which gives much soothing effect to the eyes then other three.

It means that we need to increase the contribution of green color, and decrease the contribution of the red color and make the contribution of blue color in between these two colors.

Hence we will get a new solution as:

New gray image = {(r*0.3) + (g*0.6) + (b*0.1)}

As per the above equation, Red's contribution is 30%, Green's contribution is 60% that is greater among all three colors and Blue's contribution is 10%.

Now apply above equation to any image, we get -

Figure 3.3: Original Image weighted average method

Figure 3.4: Weighted average method Grayscale

Justification

As we can see in above figure that the image has been more properly converted to grayscale image using weighted method than the average method. The output of weighted method is brighter than average method.

3.2 Binary to gray conversion

Here we will be going to use uint8 function for converting image from binary to grayscale. Function 255*uint8(binary image) converts any grayscale image i(x, y) into a binary image where uint8 is used to convert all elements of an array into unsigned 8-bit or 1-byte integers of class uint8.

3.3 Grayscale image to RGB image

After converting binary to grayscale image now we will convert grayscale image back to RGB image. For this purpose we will use functions like ycbcr2rgb(Ycbcr) that converts YCbCr color values into the colormap and ycbcrmap to the RGB color.

CHAPTER 4

IMAGE ENHANCEMENT

Preview

Image enhancement can be done in space domain as well as in frequency domain. In space domain, there is no need of pre-processing whereas in frequency domain we need to find fourier transform (FFT) and inverse fourier transform (IFT) as per requirement.

The processed image can be given as-

$$g(x, y) = T*f(x,y)$$

where T is the transformed image and f(x. y) is the original image.

4.1 Point processing Methods

In this transformation occurs on a single pixel i.e. 1x1 image.

$$S = T(r)$$

where S is the intensity of pixel at location (x, y) in processed image.

T is the operator which works on the pixel values at location (x, y)

r is the intensity of gray level in original image at location (x, y)

4.1.1 Image negative

This method is used to transform the image from black to white. If in original image pixel level is white then in processed image it will be black or dark gray and if in original image pixel level is black then in processed image it will be white or light gray.

The transformation function for this method is given as-

$$S = (L-1)-r$$

The graph for above transformation is-

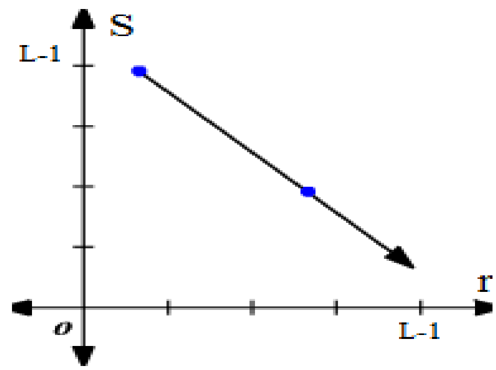

Figure 4.1: Image negative

4.1.2 Log transformation

The log transformation can be given as-

$$S = K \log_2(1 + r)$$

where K is constant. Its purpose is to increase the brightness of an image. It is also used to scale the intensity level of original image and to bring the level into approximate range in processed image.

The graph for above transformation is-

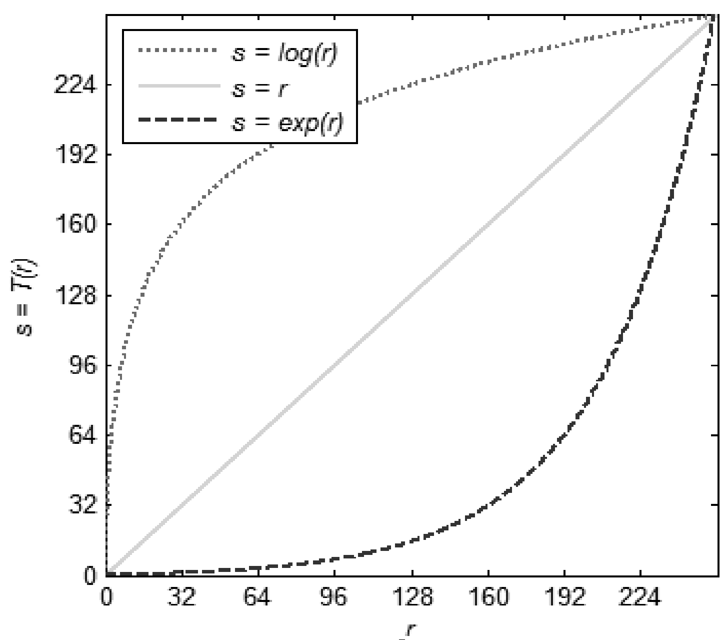

Figure 4.2: Log transformation

4.1.3 Power Law Transformation

The power law transformation is given as-

$$S = Cr^{\gamma}$$

Where C is scaling constant and its purpose is to increase the brightness of an image. It is also used to scale the intensity level of original image and to bring the level into approximate range in processed image.

This transformation is also called as gamma correction.

The graph for above transformation is-

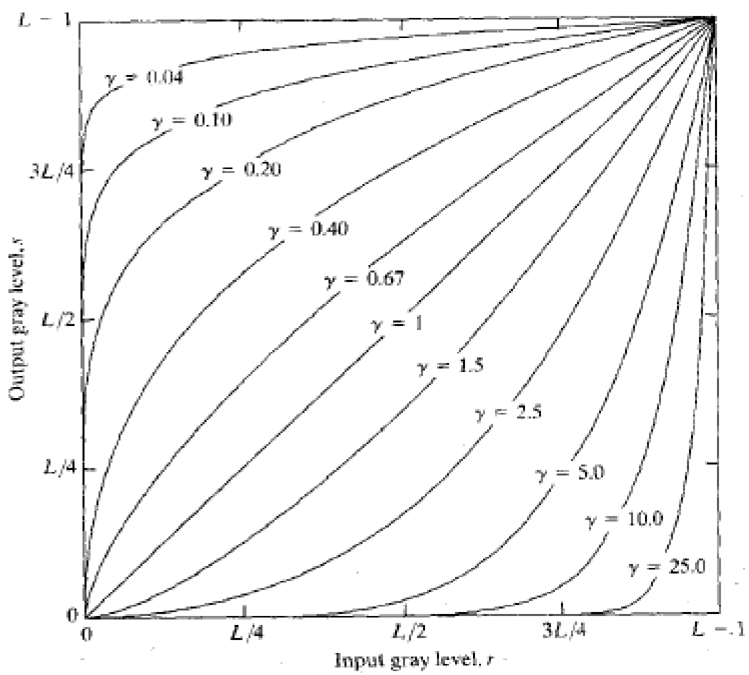

Figure 4.3: Power law transformation

4.1.4 Contrast Stretching

This method is used in improving dynamic range. The main reasons for low contrast or low dynamic range image are-

- If light condition is not proper
- Poor dynamic range of sensor

- Improper aperture setting

The graph for above transformation is-

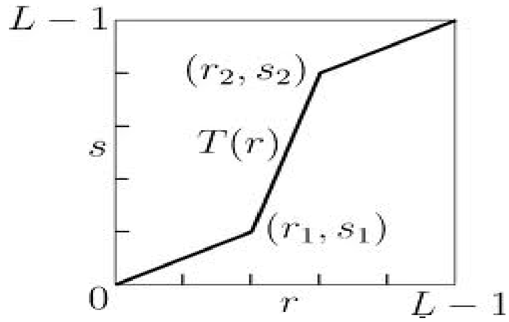

Figure 4.4: Contrast stretching

Here in this transformation: $r_1 <= r_2$

And $s_1 <= s_2$

If pixel value is dark or light in the original image then it should remain dark or light in processed image respectively. If slope will be narrow we will get light image and if slope is broad then we will get a dark image.

4.1.5 Gray level slicing

It is used to highlight any specific gray levels in an image.

The graph for above transformation is-

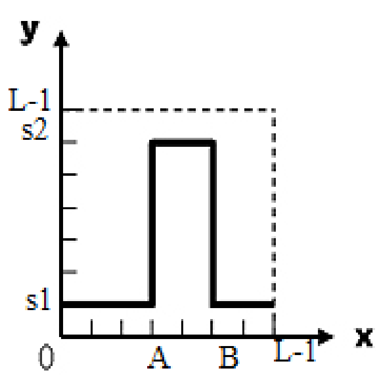

Figure 4.5(a): Gray level slicing

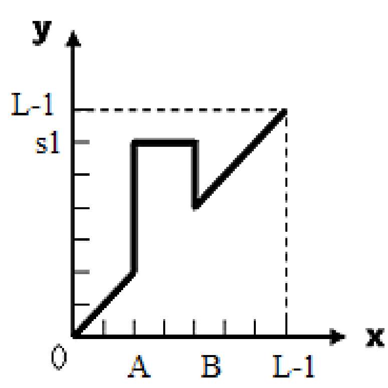

Figure 4.5(b): Gray level slicing

Figure 4.5(a) highlights or enhances the region between A and B and suppresses all other values.

Figure 4.5(a) highlights or enhances the region between A and B and all other values between 0-A and from B-(L-1) are linear that means these intensity levels are preserved in processed image.

4.1.6 Bit plane slicing

It is used in highlighting contribution made to a complete image appearance by some specific bits.

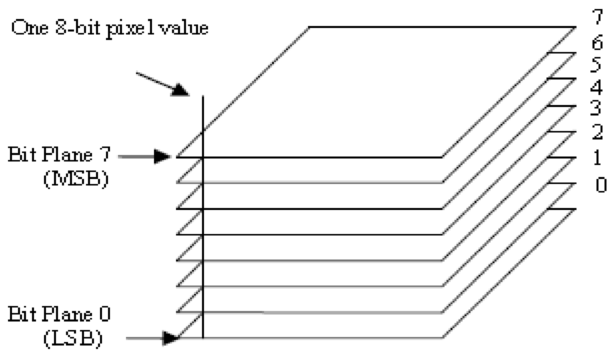

Figure 4.6: Bit plane slicing

CHAPTER 5

IMAGE RESTORATION

Preview

Image restoration is the action of taking a corrupt image and finding the original and clean image. Corruption can occur in various ways like mis-focus of camera, noise and motion blur. The main objective of image restoration techniques is to recover and regain resolution loss, to reduce noise and to maintain its quality. Image processing methods are implemented either in the space domain or the frequency domain.

It improves visual quality of an image but in this we must have prior information about degradation phenomenon of an image. Image restoration is low – level processing technique.

Image restoration depends on degradation and extent of information about degradation we have. It is an objective process based on facts.

5.1 Types of noise

5.1.1 Gaussian Noise

The probability distribution curve of this noise is same as the normal distribution curve that is why this noise is also known as normal noise. If the noise is present in electronic device than that noise is Gaussian noise.

The pdf for this is expressed as-

$$G(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Where σ is the standard deviation

μ is the mean

σ^2 is the variance

Using graph, it can be shown as-

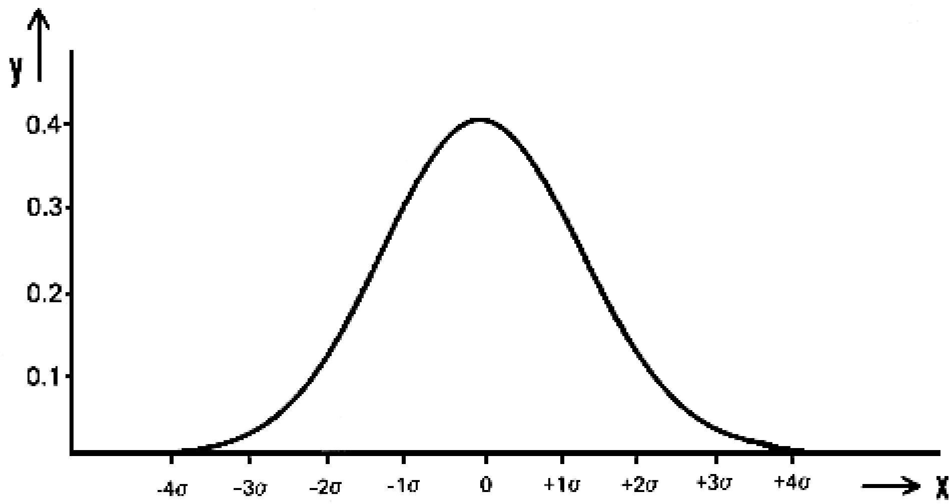

Figure 5.1: Pdf of Gaussian noise

5.1.2 Impulse Noise

Impulse noise is an unwanted noise having sharp sounds. For removal of this noise we use median filter. If the noise is present in digitization of the signal then that noise is called as impulse noise.

The pdf for this is expressed as-

$$P(q) = \begin{cases} P_i, & \text{for } q=i \\ P_j, & \text{for } q=j \\ 0 & \text{, otherwise} \end{cases}$$

Where i and j are the graylevels

P_i and P_j are the probabilities for q equals to i and j respectively.

If j>i then pixels having gray level equals to j will appear as light pixels and pixels having graylevel equals to i will appear as dark pixels.

Characteristics of impulse noise

- This noise can be positive and negative.
- They are additive in nature.
- Impulse noise is basically salt and pepper noise.

5.1.3 Rayleigh noise

The noise present due to distance is called Rayleigh noise.

The pdf for this noise is expressed as-

$$P(q) = \begin{cases} \frac{2}{j}(q-i)e^{-\frac{(q-i)^2}{j}}, & \text{for } q>=i \\ 0, & \text{for } q<i \end{cases}$$

Mean(μ) = $i+\sqrt{\frac{\pi j}{4}}$

Variance(σ^2) = $\frac{j(4-\pi)}{4}$

Using graph, it can be shown as-

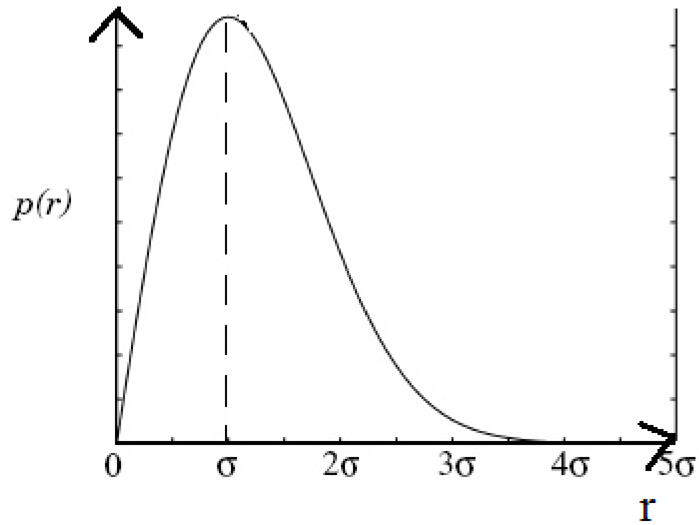

Figure 5.2: Pdf of Rayleigh noise

5.1.4 Exponential noise

The noise present in laser imaging is exponential noise.

$$P(z) = \begin{cases} a*e^{-az}, & \text{for } z>=a \\ 0, & \text{for } z<a \end{cases}$$

Mean(μ) = $\frac{1}{a}$

Variance(σ^2) = $\frac{1}{a^2}$

Using graph, it can be shown as-

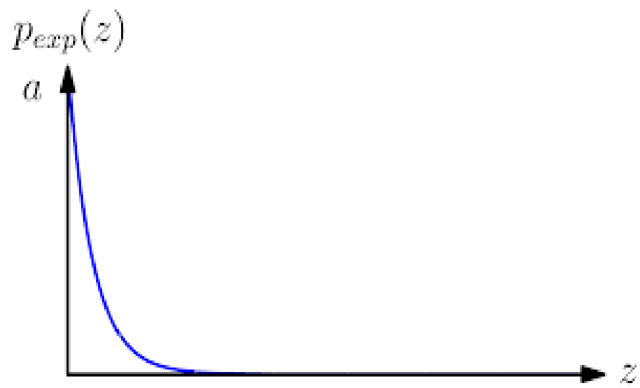

Figure 5.3: Pdf of Exponential noise

5.1.5 Gamma noise

Gamma noise is also known as Erlang noise. It is present in laser imaging.

Its pdf is given by-

$$P(z) = \frac{a^b z^{b-1}}{(b-1)!} e^{-az} \quad , \text{for } z>=0$$

$$0 \quad , \text{for } z<0$$

Using graph, it can be shown as-

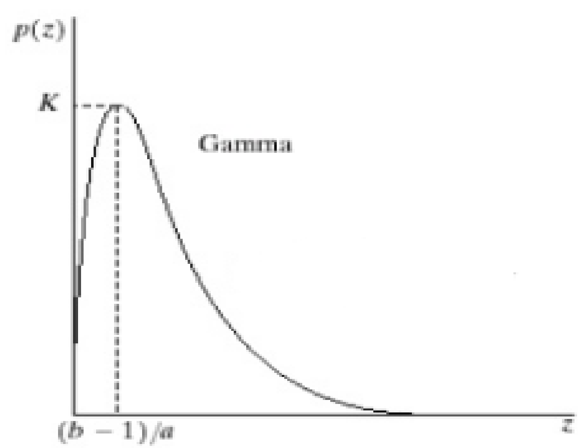

Figure 5.4: Pdf of Gamma noise

5.1.6 Uniform noise

Its probability distribution function is given as-

$$P(z) = \begin{cases} \frac{1}{b-a} & \text{,for } a<=z<=b \\ 0 & \text{, otherwise} \end{cases}$$

Using graph, it can be shown as-

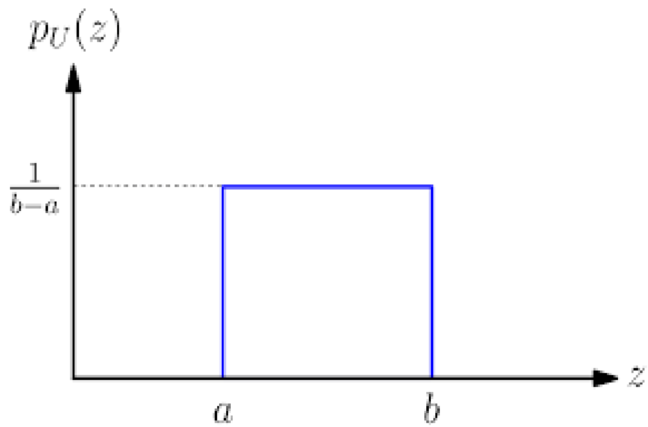

Figure 5.5: Pdf of Uniform noise

5.2 Removal of holes

For this purpose we will use imrect function whose syntax is given as-

Syntax:

p = imrect(image)

imrect provides mutual placement of rectangle on x and y axes. This syntax gives p. It creates a menu known as context menu which is associated to control the aspects of its behavior and appearance. By right clicking on this rectangle created by imrect function we can access its context menu.

5.2.1 Mutual Behavior

When we use imrect function having a syntax, we get a cross sign when the cursor is placed on image. By making a rectangle on an image, we can change its position as well as size. With right click we can open a context menu that can be used to control behavior and appearance. This description can be shown in below figure.

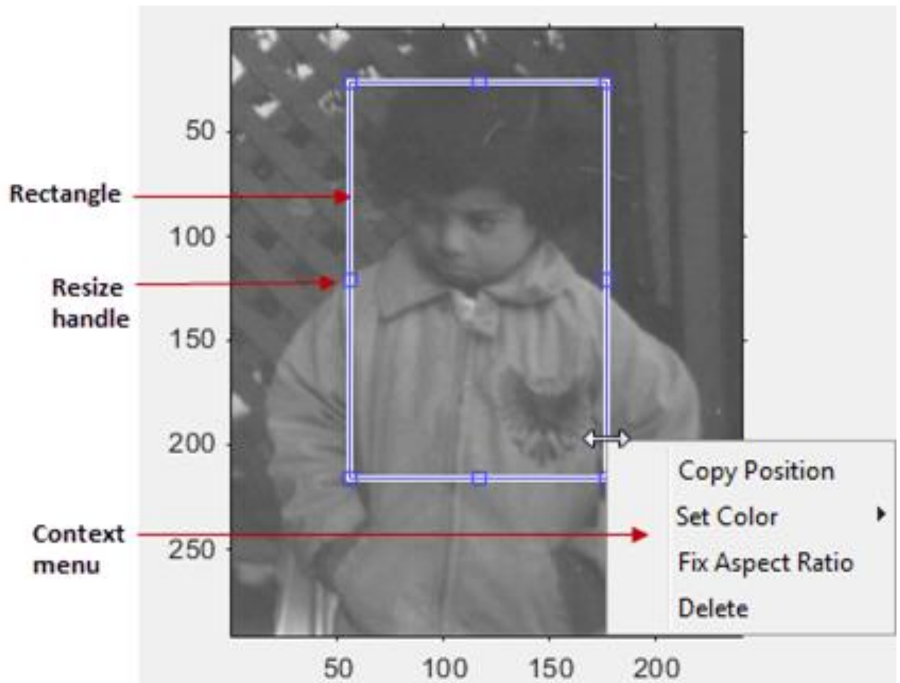

Figure 5.6: Forming rectangle to remove holes

After rectangular selection we can remove that part of an image by double clicking on it or pressing the delete button as shown in above figure.

5.2.2 Table showing imrect behavior

Table 5.1: Table showing imrect behavior

Interactive Behavior	Description
Moving the rectangle	Move the pointer inside the rectangle. The pointer changes to the fleur shape. Click and drag the mouse to make rectangle.
Resizing the rectangle	Move the pointer over any one of the edges or corners of the rectangle. The shape changes to a double-ended and drag the edge or corner using mouse.
Changing the color of the rectangle	Move the pointer inside the rectangle. Right-click and select **Set Color** from the context menu.
Retrieving the coordinates of the current position	Move the pointer inside the polygon. Right-click and select **Copy Position** from the context menu.
Preserve the current aspect ratio of the rectangle during interactive resizing	Move the pointer inside the rectangle. Right-click and select **Fix Aspect** Ratio from the context menu.
Deleting the rectangle	Move the pointer inside the rectangle or on an edge of the rectangle. Right-click and select **Delete** from the context menu.

CHAPTER 6

PROJECT DESIGNING AND IMPLEMENTATION

6.1 RGB To Gray Conversion

It converts the RGB truecolor image into gray intensity image. Here we have used rgb2gray function to convert a RGB image to gray image by removing the noise, hue by preserving the glow.

Figure 6.1: RGB image

Figure 6.2: Grayscale Image

6.2 Edge Detection Techniques

6.2.1 Canny Edge Detector –It is an edge detection approach which uses an algorithm to detect the edges in images.

Algorithm:

- ☐ Use Gaussian filter to blur the image.
- ☐ Find horizontal and vertical gradients.
- ☐ Then compute magnitude and direction of gradient.

- ☐ Perform Non-Maximal Suppression.
- ☐ Perform Hysteresis Threshold.

Figure 6.3: Canny output

6.2.2 Laplacian Edge Detector --

It is the edge detection method used in digital images where there are strong and rapid variations in image contrast.

Algorithm

- ☐ Take sample of an image
- ☐ Blur the image
- ☐ Convolve it with Gaussian filter
- ☐ Use Laplacian filter
- ☐ Find zero-crossing
- ☐ Use Median Filter

Figure 6.4: Laplacian Output

6.2.3 Sobel Edge Detector --

It enhances the edges at all those points where gradient is highest.

Algorithm

- Accept the input image
- Convolve it with small and separable filter
- Find Gx and Gy
- Find the absolute magnitude of G_x and G_y
- This will give output edges

Figure 6.5: Output of Sobel

6.3 Rectangular Selection of the object to be removed –

When we call imrect function having a syntax, we get a cross sign when the cursor is placed on image. With right click we can open a context menu that can be used to control behavior and appearance. This description can be shown in below figure.

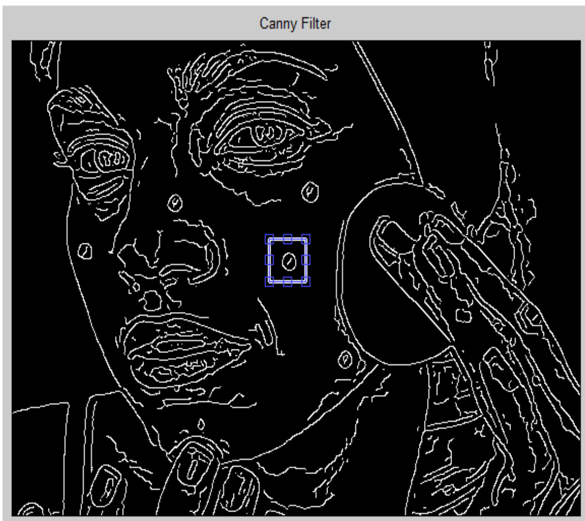

Figure 6.6: Forming rectangle to remove holes

Figure 6.7: After remove holes

6.3 Binary to Gray Conversion –

For converting the image into original image, firstly convert binary image into grayscale image.

Figure 6.8: Grayscale Output

6.5 Grayscale to RGB Conversion –

Finally convert the grayscale image into RGB image.

Figure 6.9: RGB output when pimple is removed

6.6 Comparison between our project outputs with result of most of face beautification apps –

Figure 6.10: Original image

Figure 6.11: Low pass filter

Output with 3x3 window size

Figure 6.12: Low pass filter

Output with 5x5 window size

Figure 6.13: Low pass filter

Output with 7x7 window size

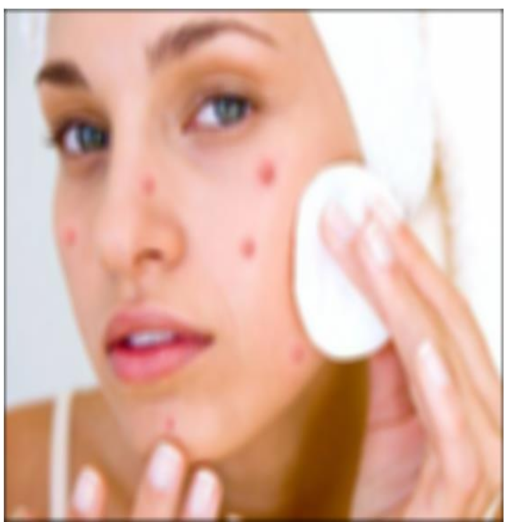

Figure 6.14: Low pass filter

Output with 9x9 window size

Figure 6.15: Low pass filter

Output with 15x15 window size

6.7 Removal of Patches

To remove a patch, we have used bwlabel. bwlabel is used to connect two-dimensional binary objects with the help of which we can remove a complete patch from the face.

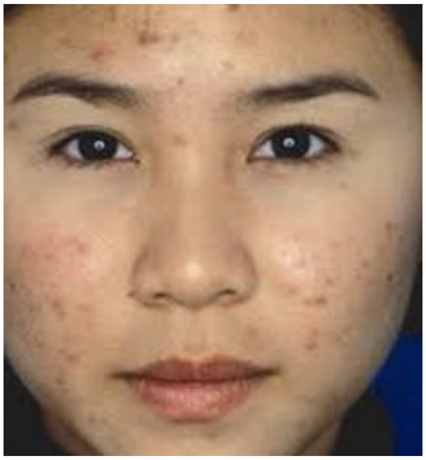


Figure 6.16: Original image with patches

Figure 6.17: Output after removal of patches

6.8 Whitening of teeth

- We have taken an image of yellow teeth.
- Then we used imtool() function to get the information about RGB range. Then with the help of this knowledge we were able to set the threshold value.
- Then we converted the complete range taken under threshold value into the white color.


Figure 6.18: Yellow teeth

Figure 6.19: White teeth

6.9 Rotation of image

We have developed an algorithm to rotate an image without using the built in functions. Here firstly we will try to rotate an image using built in functions and then we will explain our algorithm.

1. rot90(A,k): This function is used to rotate image by 90 degrees.
2. flipud(A): This is another function to rotate an image by 90 degrees. Flipud function is used to flip the matrix up and down.
3. fliplr(A): This function is used to flip the matrix left and right

Now we will explain the algorithm to rotate an image without using matlab inbuilt functions. Steps to perform this algorithm are given below:

a. Find out the midpoints of an image.

b. Convert each pixel co-ordinate into polar co-ordinate.

c. The conversion result will give radius and angle of an image.

d. Convert that angle that is in radians into degree, using the function rad2deg (Θ).

e. Add the value obtained in the above step with the degree value to which you want to rotate an image.

f. Again convert the degree into radian by using rad2deg inbuilt function.

g. Now convert it into Cartesian co-ordinate by using the pol2cart(theta,radius) function.

Figure 6.20: Image before flip

Figure 6.21: Horizontal flip

Figure 6.22: Vertical flip

Figure 6.23: Horizontal + Vertical flip

6.10 Contrast Enhancement

It converts dull image or low contrast image into high contrast image.

Some of the enhancement techniques are-

- imadjust
- histeq
- adapthisteq

Figure 6.24: Image with low contrast

Figure 6.25: imadjust output

Figure 6.26: histeq output

Figure 6.27: adapthisteq output

6.11 Brightening of an image

Brightening of image is the process of adjusting brightness so that the results are more suitable for the purpose of display. In this we increase or decrease the color intensities by replacing the present color with a lighter or darker color as per the requirement.

Figure 6.28: Less Brightened image

Figure 6.29: Brightened image

6.12 Results Observed

- As window size of low pass filter is increased, pimples are fading but the complete image is blurred. When we compare our result with this, we have found that we can remove only that object that we want to without blurring the complete image.
- We have removed a complete patch of pimples in one go.
- We have whitened the yellow teeths.
- Then we rotated the image in any direction that we want.
- Using contrast enhancement technique we have improved the quality of an image.
- At last, we have brightened the image.

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https://www.google.co.in/search?q=gamma+noise&espv=2&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjEvOXL_rnTAhUBs48KHYHMDBsQ_AUIBygC&biw=1366&bih=662#imgrc=7y3k3FSmaLA25M:

http://in.mathworks.com/help/images/ref/imrect.html

https://www.google.co.in/search?q=girl+with+pimples&espv=2&tbm=isch&imgil=1cFatCrb5vtCVM%253A%253Ba36eQVRhoLEA7M%253Bhttps%25253A%25252F%25252Fwww.buzzfeed.com%25252Frachelzarrell%25252Fpop-til-you-drop&source=iu&pf=m&fir=1cFatCrb5vtCVM%253A%252Ca36eQVRhoLEA7M%252C_&usg=__Eha0n2_L2mnBD6kPvUD82dSd4dQ%3D&biw=1366&bih=662&ved=0ahUKEwiRjK6X_7nTAhUJsY8KHTDACSAQyjcILQ&ei=bE_8WJGmJ4nivgSwgKeAAg#imgrc=1cFatCrb5vtCVM:

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APPENDIX A

GENERAL MATLAB FUNCTIONS

clc –clears all input and output data from the Command Window

clear all - clears all objects in matlab workspace

close all-deletes all figures.

imread(FName)-reads image from the file given by FName,

imshow(X)- displays the image X in a form of figure.

figure/figure(I)- makes the current figure visible in new window.

title(t**)** **–**adds the title at the top and in center of the axes.

subplot()- used for plotting multiple graphs or images in the same figure.

APPENDIX B

MATLAB FUNCTIONS USED

edge(X,'Canny') - detects edges using Canny edge detection method.

imfilter(B,x,’conv’) - filters the multidimensional array B with filter x.

edge(X,'Sobel') - detects edges using the Sobel edge detection method. It returns edges at those points where the X’s gradient is maximum.

fspecial('lapl’) - returns a 3x3 filter by approximating the shape of 2-D Laplacian operator.

colormap(m) - sets colormap for any figure to the colormap given by m.

rgb2gray(c) -converts the RGB image to the grayscale image.

im2bw(X, L) –gives the binary image from grayscale image.

imrect(hp) –provides placement of a rectangle on object given by hp.

imwrite(X,FName) -writes image information X to the file given by FName.

bwlabel(b) -returns the matrix containing labels for 8-connected objects. The output matrix is the same size as b.

uint8(array) -converts attributes of an array into unsigned 8-bit integers of uint8.

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