“Image Processing: Image Enhancement and Edge Detection Techniques”

Project report submitted in fulfilment of the requirement for the degree of Bachelor of Technology

In

Computer Science and Engineering

By

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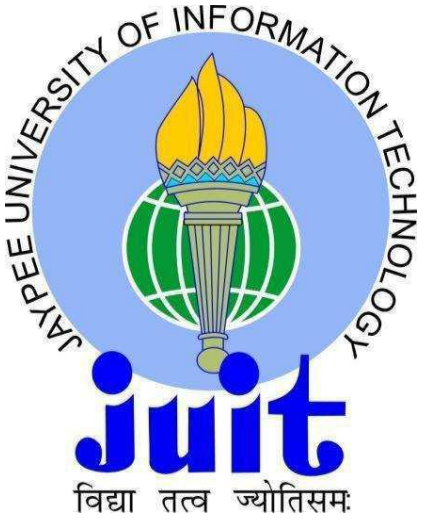
Under the supervision of

(Dr. Amit Kumar Singh)

To



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CERTIFICATE

Candidate's Declaration

I hereby declare that the work presented in this report entitled **"Image Processing: Image Enhancement and Edge Detection Techniques"** in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering/Information Technology** submitted in the department of Computer Science & Engineering and Information Technology**,** Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out over a period from July 2017 to May 2018 under the supervision of **Dr. Amit Kumar Singh** (Assistant Professor, Senior Grade, Computer Science &Engineering Department).

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

Shivika Agarwal, 141234

This is to certify that the above statement made by the candidate is true to the best of my knowledge.

Dr. Amit Kumar Singh
Assistant Professor, Senior Grade
Computer Science and Engineering and Information Technology
Dated:

ACKNOWLEDGEMENT

We owe our profound gratitude to our project supervisor **Dr. Amit Kumar Singh**, who took keen interest and guided us all along in my project work titled - **"Image Processing: Image Enhancement and Edge Detection Techniques"**, till the completion of our project by providing all the necessary information for developing the project. The project development helped us in research and we got to know a lot of new things in our domain. We are really thankful to him.

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ABSTRACT

In underwater situations, light absorption and scattering lessen the quality of the image due to which one colour is dominated in the image. Light quickly loses intensity as it voyages in water, depending on the color range wavelength. As we know that the visible light is ingested at the longest wavelength first. Red and blue are the foremost and least ingested, respectively. Underwater images with low contrast are captured due to the degradation effects of light spectrum due to which the important information from the captured images cannot be extracted fully for further processing. Hence it is very important to apply image enhancement techniques before processing the image further.

Edge detection has become a very important task in digital image processing. With the help of edge detection, we can easily segment the images and recognising the pattern also becomes easy. It also helps in object detection. Various edge detectors available for detecting the edges include Canny, Sobel, Laplacian of Gaussian, Robert's and Prewitt, Marr-Hildreth. So secondly, we applied different edge detection techniques and aimed at analysing these techniques on the basic of performance parameters.

As we know that noise can creep into the images. So, it is important to remove that noise first otherwise the edges won't be sharp. Thirdly, we apply various filters and combination of filters to remove the noise and then analyse which filter or combination of filter gives best results.

CHAPTER 1

IMAGE PROCESSING: AN INTRODUCTION

Image processing is a strategy to get an improved image or to extricate some valuable data from the image by applying certain procedure on the existing raw image [6]. Image processing basically includes three steps

1. The image is imported using image acquisition tool
2. The image is then analysed and then manipulated
3. Then comes the output in which the result may be an altered image, or it may be in a form of report of image analysis.

Image processing is of two types namely, analog and digital image processing. In analog image processing analogue signals are processed and the images are processed by electrical means. The most common example of analog processing is the television image. In digital image processing, we deal with digital.

Image

An image is a 2-dimensionalfunction F(x, y) , where x and y are spatial coordinates and amplitude of F at any pair of coordinates (x, y) is called the intensity or gray level of the image[8].

Types of Images

- Binary Image: These are the types of images which take discreet values (0 or 1). Since only two values are taken, hence they are called binary images. Black color is denoted by 1 and white color by 0.
- Gray scale images: These images are also known as monochrome images since they do not represent any color. They only state the level of brightness for one color. This type of images consists of only 8 bytes.0 denotes black and 255 represents white and in between are various levels of brightness.
- Colored images: These images containthree bands namely red, green and blue. The intensity of all the three bands is 8 bytes. The various intensity levels in each band convey the entire colored image. The size of colored image is 24 bits.

Image Processing

Image processing includes procedures to convert a real time image into digital image and perform some operations on it. With the help of this we can get an enhanced image and some important information can also be extracted [6].

Various image Processing Techniques are:

- Image representation
- Image pre-processing
- Image enhancement
- Image restoration
- Image analysis
- Image segmentation
- Image data compression.

Image Enhancement

The image enhancement method is mainly used to analyse the raw image and then process that image so that the quality of output image is better as compared to the input raw image [2]. With the help of these techniques, we can enhance the images and the quality of the images can also be improved for processing further. It also highlights various interesting details in images and also helps in making images more visually appealing. The image enhancement techniques help in making an image useful for various applications.Various enhancement methods are available for improving the contrast of the image. These include simple contrast stretching techniques, filtering and also image transforms [5]. The most common techniques include global histogram equalisation and histogram specification which helps in making the histogram of an image uniform over all intensity levels and follow a specific pattern [2].

Underwater cameras are broadly utilised to observe the sea floor [11].In spite of being an imperative figurein monitoring underwater scenes, there exist numerous issues with recent underwater camera sensors. There are numerous limitations in underwater imaging in comparison to land photography. First, due to the presence of medium(water), scattering always causes a blurring effect in underwater photography. This often do not occur in land photography. Second, wavelength absorption usually causes the color to diminish in the captured images, which seldom occurs in air. Third, except for electronic noise, the silt in the water also influence high dimensional imaging [6].

Existing Techniques for Image Enhancement

- Image Negative
- Log Transformation
- Grey Level Slicing
- Contrast Stretching
- Bit Plane Slicing
- Power Law Transformation

Edge detection

The process of object detection incorporates loading an image,processing the image, filtering and scaling of the image to find the object [10]. Currentlyto detect underwater submarines, sonar technique is used. Object Detection is done by extracting boundary information and reducing noise [12].

With the help of edge detection, sharp discontinuities can be located and easily identified in an image. The discontinuities are sudden changes in pixel intensity which tells the boundaries of objects in a scene. Edge detection is required in various systems like vision systems and object recognition systems. There are a large number of edge detection operators which exist and each of them is designed to be sensitive to certain types of edges [13]. Edge detection is done on the basis of various variables namely Edge orientation, Noise environment and Edge structure. As we know that the noise and the edges have high frequency content, so edge detection is difficult in noisy images. Attempts to reduce the noise result in blurred and distorted edges [15].

Various edge detectors include:

- Prewitt Operator
- Sobel Operator
- Robinson Compass Masks
- Laplacian Operator
- Marr-Hildreth Operator

Above mentioned all the filters are Linear filters or smoothing filters.

Image Restoration

Image restoration techniques are used to reduce the noise and recover resolution loss. A corrupt image is taken and then with the help of various techniques original images are estimated. Image restoration was first used in astronomy but now it is used in other fields also like medical, media etc [16]. It is different from image enhancement because the main aim of image enhancement is to produce an image that is pleasing to the observer.

Image Segmentation

Image segmentation techniques are used to partition a digital image into many segments. It is used to make the representation of an image simpler and easier to analyse. It is used in face recognition, medical imaging(for locating tumour, for surgery planning, for measuring tissue volume), traffic control systems, video surveillance etc.

Various image segmentation techniques are:

- Threshold technique
- Point transformation
- Watershed technique
- Wavelet transformation technique

The proposed project is an aim at providing better image enhancement methods to rectify the image and identify edges of an image. Later, the image is processed for removal of noise that may be introduced during transmission.

1.1) PROBLEM STATEMENT

With the extending use of underwater images in military and defence, fish localization and detection in submarine environment, marine life research, wreck locations, positioning of oil rigs, it has become necessary for the images to be enhanced and color corrected. Since a lot of development is going on in the field of medical, edge detectionis also required to localise required object.

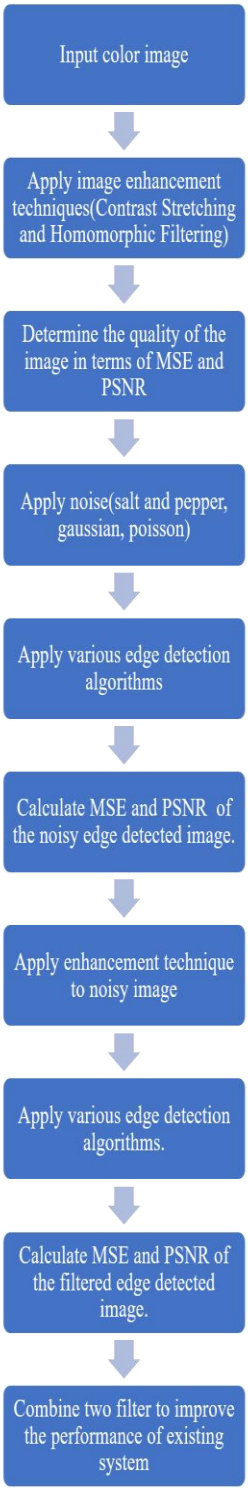
This project aims at identifying the techniques that can be used for image enhancement, edge detection and removal of noise during transmission of images by using multiple algorithms and testing them for variousimages.

1.2) OBJECTIVE

The objective of our project is:-

- To improve the performance of the existing image enhancement techniques for underwater image in terms of PSNR, MSE.
- Apply Salt and Pepper Noise.
- Improve Quality of Image against Attack.
- Apply Edge detection Techniques (Canny, Prewitt and Marr-Hildreth).
- Calculate PSNR.
- Combine 2 filters to improve the performance of Existing system**.**

1.3) METHODOLOGY



CHAPTER 2

LITERATURE REVIEW

- In [1], the authors have proposed a technique based on slide stretching for improving the perception of underwater images. Two steps are followed: - Firstly, contrast stretching in RGB domain is done to equal the colour contrast in the images. Secondly, the saturation and intensity stretching of HSI is done so as to up level the true colour and unravel the problem of lighting.

Figure 1 represents the methodology used for image enhancement in the given paper.

Figure 1: Methodology used for image enhancement [1]

By applying two stretching models an added advantage is gained because is it helps to equalize the colourcontrast in the images. The issue of lightning is also addressed.

- In [2], the authors have proposed a technique to improve the low contrast of images. A software is designed for enhancement using contrast stretching on RGB and IHS digital image models. Figure 2 represents the flowchart of the system used in the paper.

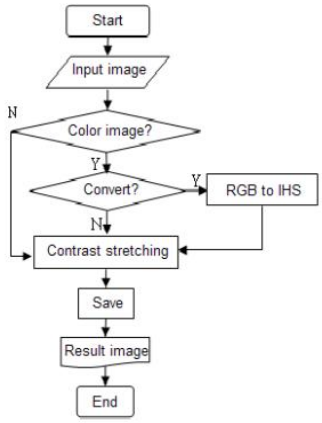


Figure 2: Flowchart of the system [2]

The figure 3 below represents the contrast stretching algorithm applied on the image Bird.bmp

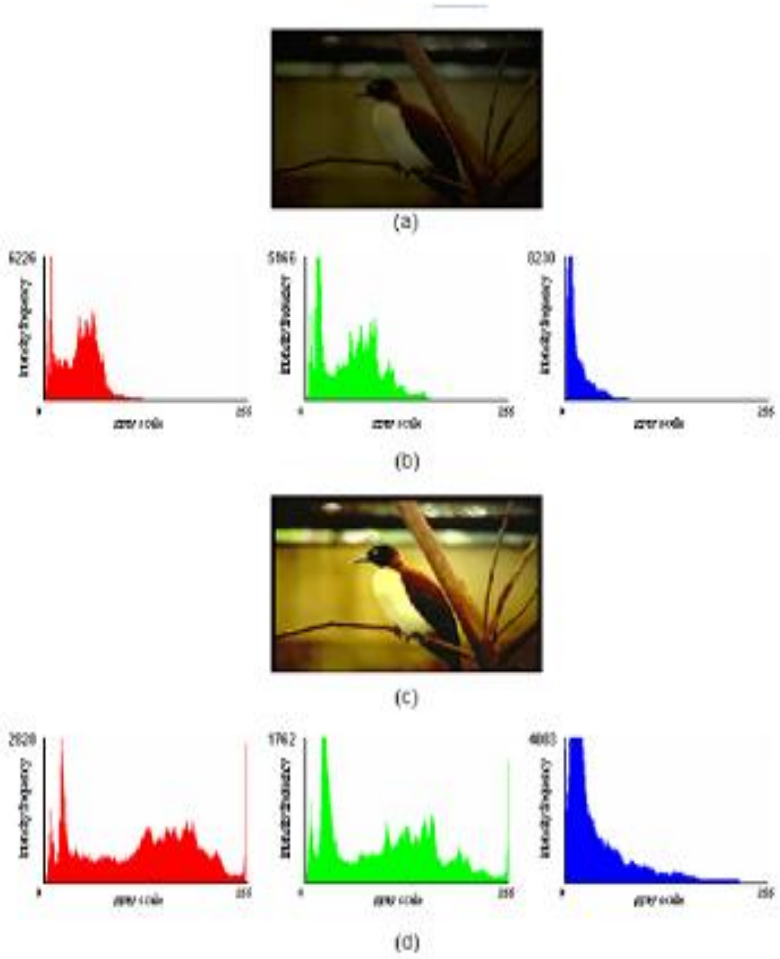


Figure 3: Contrast Stretching on Bird.bmp [2]

The improvement of image quality can be seen by the expansion of its histogram by adjusting the contrast strength coefficient and the centre of contrast.

- In [3], the authors have proposed a technique for improving the existing homomorphic filtering. A new filter is made which is based on the low frequency filter and a high pass filter. The figure 4 below shows the profile of Homomorphic Filter's Transfer Function H (u, v).

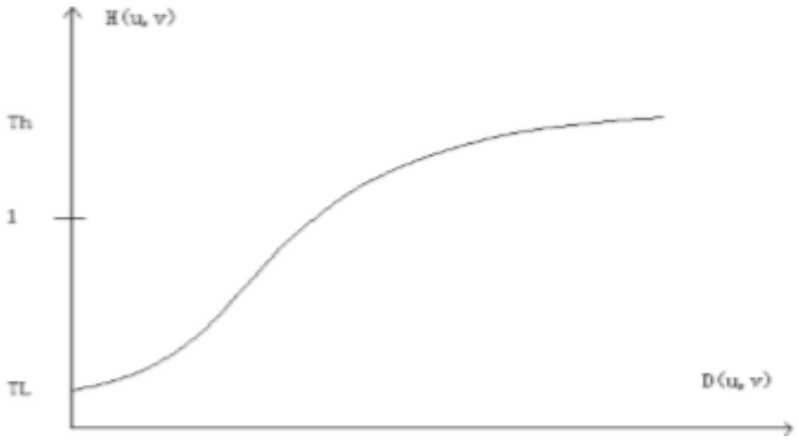


Figure 4: The Schematic Profile of Homomorphic Filter's Transfer Function H(u,v) [3]

The figure 5 below shows the Schematic Profile of Improved Homeostasis Filter.

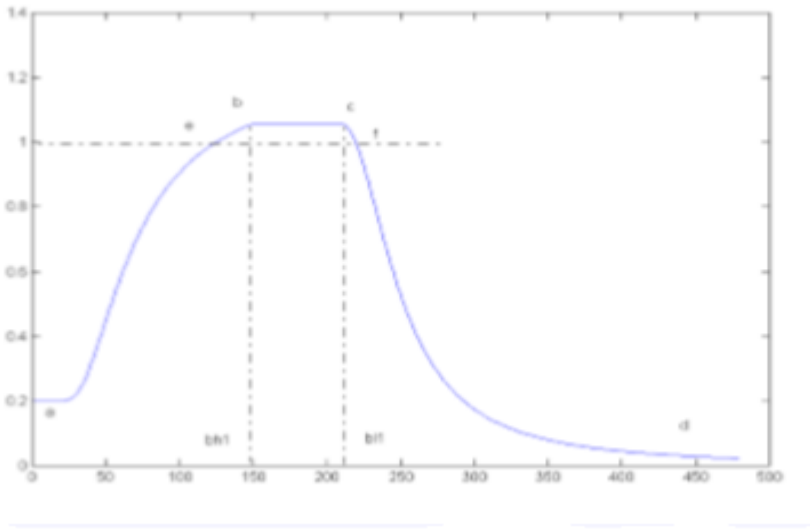


Figure 5: Schematic Profile of Improved Homeostasis Filter [3]

Since the improved filter used the parameters which are flexible and can be deformed according to the actual situation hence the new filter is an effective one.

- In [4], the authors proposed a technique to enhance the quality of underwater images using stretching process followed by the Rayleigh distribution and it also sets the limits to the output image. A bell-shaped distribution of the image pixels is obtained. The figure 6 below shows the flowchart of the proposed model implementation.

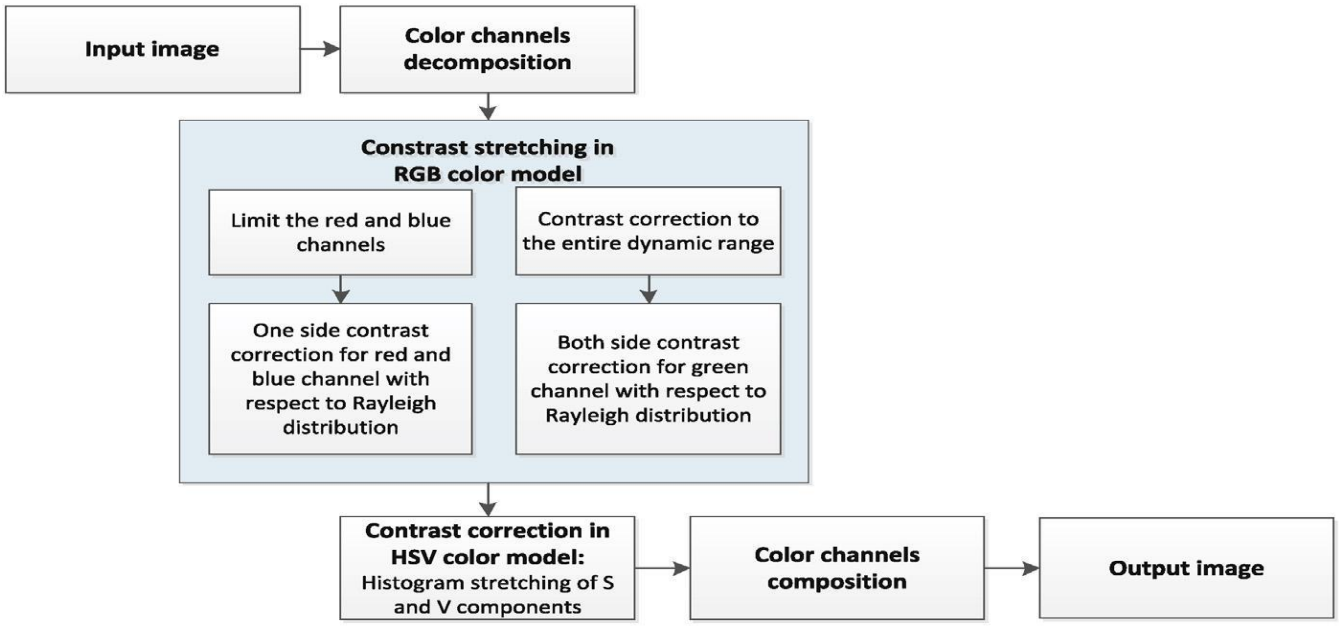


Figure 6: Flowchart of implementation of proposed model [4]

.With the help of the method proposed in the paper, the noise is reduced up to a great extent as compared with that of the other methods. The dominance of blue-green illumination effect is significantly reduced.

- In [5], authors have surveyed various techniques for underwater image enhancement.Various filtering techniques areavailable in the literature for processing and enhancement of underwater images. One of them includes the enhancement of the image using median filter. It helps in enhancing the image and up level the quality of image by removing noise particles with the help of different techniques, and the other is RGB Color Stretching. The figure 7 below shows the block diagram for image enhancement.

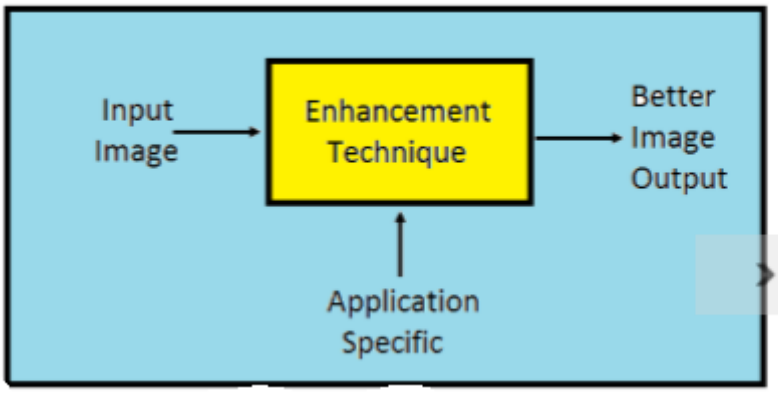


Figure 7: Block diagram for image enhancement [5]

To eliminate the noise, Gaussian blur method, a low pass filtering method is used because noise was not removed by only applying contrast histogram stretching technique. But USM technique can really up level the look of the image and get the output image more progressed by applying two stages of USM which will help to decrease the complexity of the system.

- In [6], the authors have proposed the techniques for image restoration and image enhancement. The image enhancement techniques are compared on the basis of two performance metrics namely, MSE and PSNR. Various techniques used to solve the lightning problem have also been reviewed.The present challenge to the image processing community includes the difficulty associated with obtaining visibility of objects at long or short distance in underwater scenes.

- In [7], the authors have proposed a technique for underwater image enhancement using quaternions. Quaternions (or hyper complex numbers) are nothing but complex numbers in four dimensions. These were proposed by Hamiltonin in the year 1843. Quaternions are used with color space since a long time. These are in the form of complex number which have one real part and three imaginary parts.Quaternion method is based on light attenuation inversion. When applied to the white, the attenuation gives a hue vector which characterizes the water color.The objects remain

fully colored while pixels of water areas of processed images are usually gray or color with a low saturation.The figure 8 shows theimage correction using quaternion.

Figure 8: Image correction using quaternion method(a, c) Original image (b,d) Enhanced image [7]

The contrast and color dynamics of underwater images have been improved upto a great extent by the method proposed in this paper. This was done by turning water pixels to gray or low saturation colorwhereas objects remain fully colored.

- In [8], the authors have proposed an extended matlab image processing toolbox to implement some useful optical image processing and mosaicking algorithms. The algorithm used is contrast limited adaptive histogram specification (CLAHS) which bargains with the non-uniform lighting in underwater imagery.The idea behind the technique is to first subdivide the original image into regions of equal area. The concept of a clip limit is utilised to restrain the amount of contrast enhancement, specifically in homogeneous regions. The figure 9 below shows the histogram specification using the proposed method.

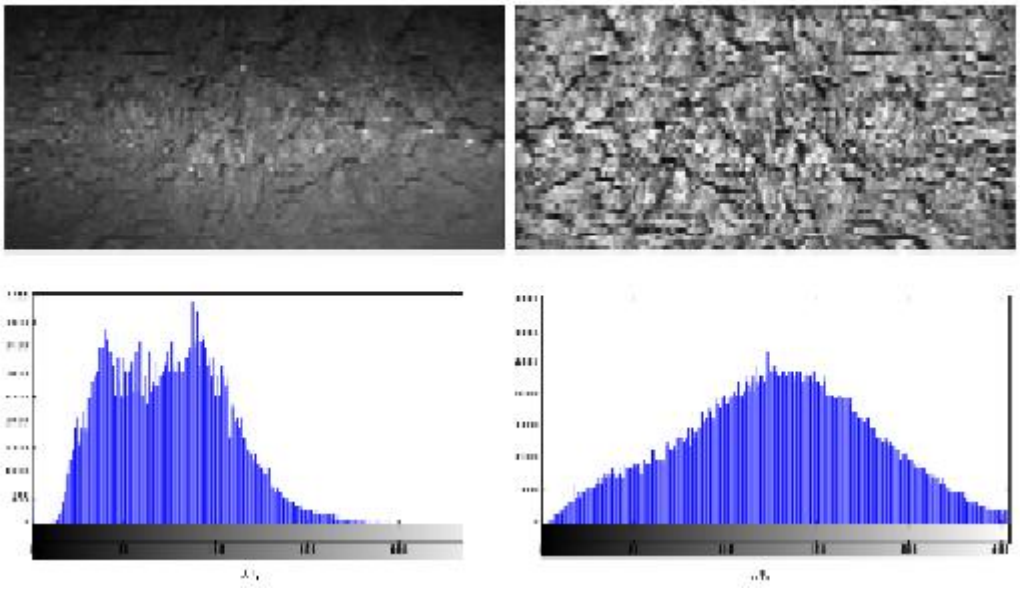


Figure 9: Histogram specification using the proposed model [8]

- In [9], the authors have proposed a technique for object detection which was then compared with the existing edge detection techniques. The process of object detection includes loading an image, pre-processing the image, filtering and scaling the image to find the object. The figure 10 below shows the system block diagram.

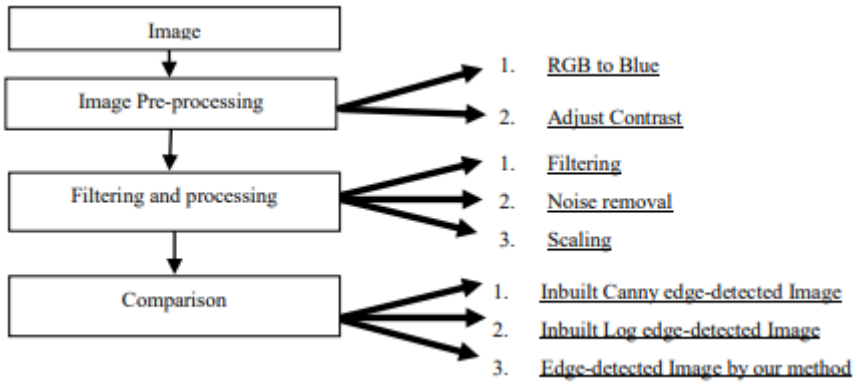


Figure 10: System block diagram [9]

The output given by method that is proposed in paper works almost the same as inbuilt 'log' function but it is superior to inbuilt ‘log’ function only in some cases but it is better to inbuilt 'canny' function in all cases.

- In [10], the authors have proposed an underwater image dehazing algorithm which uses the principle of minimum information loss and helps in restoring the visibility, color, and natural appearance of underwater images. The proposed algorithm is simple and an effective contrast enhancement algorithm and is based on histogram distribution prior. The performance of the proposed method is measured using several evaluation metrics. Various metrices like MSE, PSNR, entropy, patch-based contrast quality index, underwater color image quality evaluationand processing timehave been employed.

  The table 1 below shows the above results

QUANTITATIVE RESULTS FOR THE IMAGES OF CHALLENGING SCENES.

Method	MSE	PSNR (dB)	Entropy	PCQI	UCIQE
SID	1690.7	15.851	5.6293	0.6555	0.4249
DCP	638.06	20.082	6.8610	0.8956	0.4549
CB	1168.5	17.455	6.4079	0.8314	04543
WCID	1013.3	18.073	6.7445	0.7535	0.4391
HE	1556.3	16.209	7.1564	**1.0022**	0.4474
PB	1130.6	17.598	6.5846	0.7447	0.3828
ODM	**551.44**	**20.716**	6.9249	0.8252	0.4809
OCM	2984.8	13.382	**7.7986**	0.9052	**0.5939**

Table 1: Quantitative Result of underwater images [10]

- In [11], the authors have proposed a pairwise MRF-BP approach forColor Correction. The most probable color assignment for each pixel in the given bluish image is detected by using the belief propagation (BP) algorithm. This helps the system to adapt the restoration algorithm which can work according to the current environmental conditions. The figure 11 below shows an example of color correcting and deblurring at the same time.

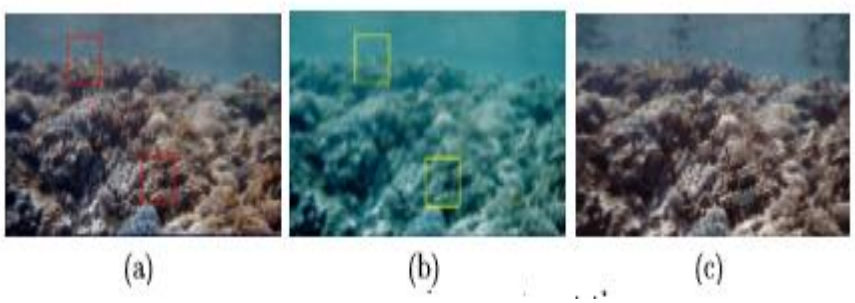


Figure 11: Example of Color Correcting and Deblurring at the Same Time (a) Input image (b) training pair indicated in the original image (c) color corrected and deblurred image [11]

- In [12], the authors have surveyed various edge detection techniques such as Prewitt, Robert, Sobel, Marr- Hildreth and Canny operators to analyse which technique worksbetter on the basis of various parameters like adaptive in nature, which technique performs good in case of noisy image, gives blunt edges and also has a lowprobability of detecting false edges. The figure 12 below shows the hierarchy of the edge detectors.

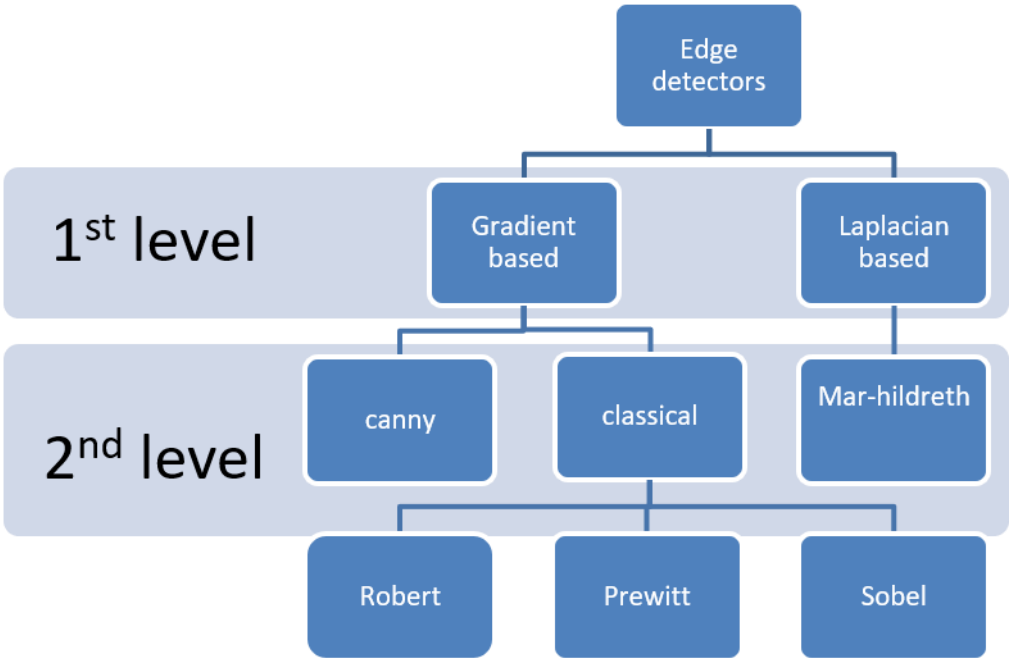


Figure 12: Hierarchy of edge detectors [12]

It was found that canny edge detection technique works well in almost all the situations. It is adaptive in nature and also less sensitive to noise since it uses the gaussian filter.

- In [13], the authors have comparedvarious algorithms on the basis of PSNR and MSE. To evaluate the performance of edge detections algorithms first of all true edges are detected, processing time is calculated, error ratio if found, and then the noise level is checked. If an operator gives less value of PSNR and a high value of MSE for a particular image, then it means that the operator has high edge detection capability. The figure 13 and 14 below shows the comparison of various edge detectors on the basis of PSNR and MSE.

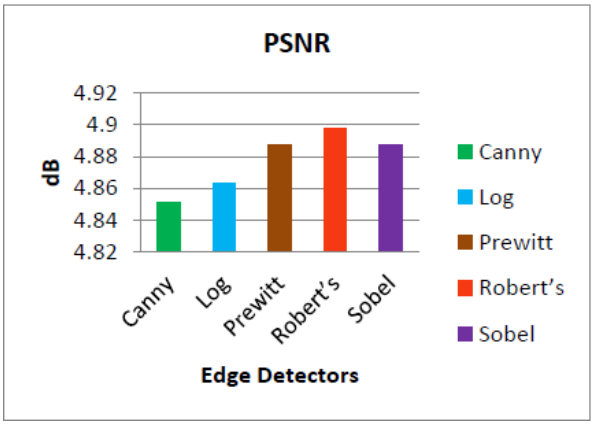


Figure 13: Comparison of PSNR values of various edge detectors [13]

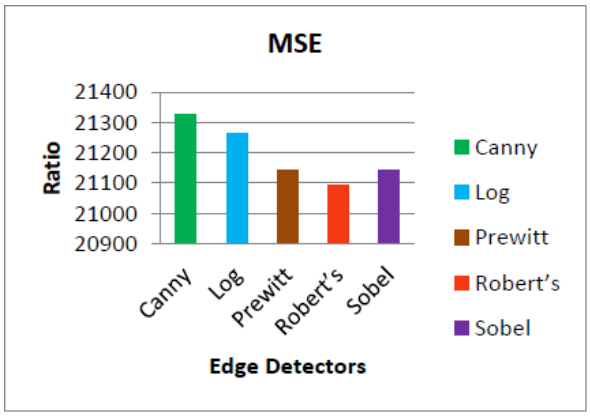


Figure 14: Comparison of MSE values of various edge detectors [13]

On comparing various edge detectors, it was found that Canny methods gave low PSNR value and high MSE values. So, it the best method and it works well in almost all the situations. But in terms of processing time Prewitt operator works well as compared to other operators.

- In [14], the authors have discussed the various types of noise that can creep into the imagesduring acquisition, transmission, or retrieval from storage media. Multiplicative noise means that there is some alteration in the brightness of the image. Example of multiplicative noise is Speckle noise.The digital image acquisition process converts an optical image into a continuous electrical signal which is then sampled. Due to some natural phenomena there are some fluctuations at every step which leads to the addition of few irregular values to the precise brightness value for a given pixel. This type of noise is known is as the additive noise. Example of additive noise are Gaussian noise, Salt and pepper noise. The figure 15, 16, 17, 18 below shows Gaussian noise, Salt and pepper noise, Speckle noise and Poisson noise respectively.

Figure 15: Gaussian Noise [14]

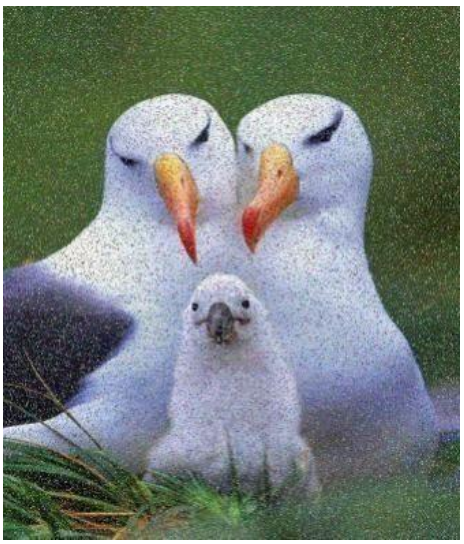


Figure 16: Salt and Pepper Noise [14]

Figure 17: Speckle Noise [14]

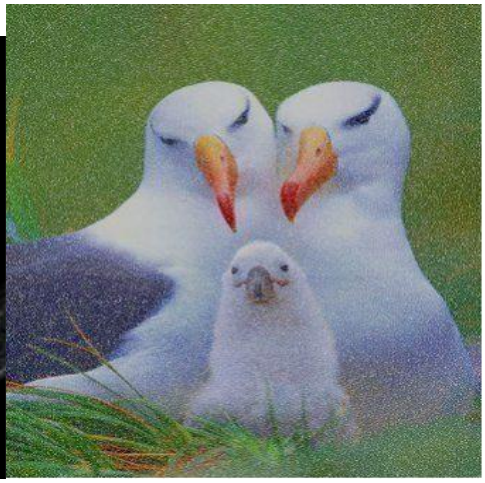


Figure 18: Poisson Noise [14]

- In [15], the authors have proposed the technique to expel the noise from the image and then each filter is compared so as to find out which filter works better with which type of noise.Mean filter diminishes the noise in the image by lessening the amount of intensity variation between one pixel and its neighbouring pixel. Each pixel value in an image is changed with the average value of its neighbours, including itself. It is a kind of convolution filter. In Median filter rather than replacing each pixel value in an image with the average value of its neighbours, the value is replaced by the median.Weiner filters are often applied in frequency domain. It is based on MSE. It is a linear filter and work on the images that are corrupted by additive noise and blurring. The table 2, table 3, table 4 below shows the PSNR values for different aerial images with different percentage of Gaussian noise, Salt and pepper noise and Speckle noise.

Filter Type	10%	20%	30%	40%	50%
Mean	19.1459	13.8813	10.6965	8.6638	7.4774
Median	18.9614	13.7423	10.4684	8.316	7.1388
Winner	19.157	13.8704	10.6783	8.6485	7.4603
WT	19.0099	13.8272	10.6572	8.6416	7.4591
CT	3.774	2.5709	1.5864	0.8424	0.3711

Table 2: PSNR Values for Aerial Images with Different Percentage of Gaussian Noise Denoised by various filters including Mean Filter, Median Filter, Weiner Filter, Wavelet Transform and CT [15]

Filter Type	10%	20%	30%	40%	50%
Mean	23.56	21.1364	19.5447	18.3204	17.3142
Median	29.1789	27.0061	23.0208	18.9895	15.5276
Winner	20.2323	18.7362	17.731	16.9448	16.2626
WT	22.1862	22.357	20.9999	19.9032	18.9215
CT	5.067	4.8672	4.641	4.4145	4.1855

Table 3: PSNR Values for Aerial Images with Different Percentage of Salt and Pepper Noise Denoised by various filters including Mean Filter, Median Filter, Weiner Filter, Wavelet Transform and CT [15]

Filter Type	10%	20%	30%	40%	50%
Mean	23.3333	21.0551	19.6126	18.6434	18.004
Median	20.3393	17.6261	16.0143	14.867	14.0018
Winner	22.2923	19.83	18.4337	17.4819	16.9623
WT	23.9933	22.3416	21.1846	20.2607	19.6573
CT	5.1022	4.8554	4.6499	4.4809	4.3551

Table 4: PSNR Values for Aerial Images with Different Percentage of Poisson Noise Denoised by various filters including Mean Filter, Median Filter, Weiner Filter, Wavelet Transform and CT [15]

In case of Gaussian noise almost all the filters and transformation techniques performed the same. For salt and pepper noise the filters proved to be more effective as compared to the transforms. The performance of the median filter was best.

2.1) Summary of Existing Techniques

Year	Author	Title	Approach	Result
2007	Iqbal et al. [1]	"Underwater image enhancement using an integrated color model"	Enhancement based on slide stretching. Technique for natural and artificial illumination.	Analysis of histogram.
2002	Garcia et al. [16]	"On the way to solve lighting problems in underwater imaging"	Compensating for lighting problems: non-uniform illumination.	Visual inspection.
2012	Chiang et al. [17]	"Underwater Image Enhancement by Wavelength Compensation and Dehazing"	Wavelength Compensation and Dehazing	Dehazing and improvement in quality of images in deep water
2005	Torrez-Mendez and Dudek [18]	"Color correction of underwater images for aquatic robot inspection"	Energy minimization formulation.	Error is calculated between the true and corrected images.
2008	K. Firdausy et al. [2]	"Image enhancementusing contrast stretching on RGB and HIS digital image."	Contrast Stretching	Quality of image is improved. Adjustment of the contrast strength coefficient.
2012	Gu Hailan and Lv Wenzhe [3]	"A Modified Homomorphic Filter for Image Enhancement"	Homomorphic filtering	Performance of existing filter is improved.
2010	Iqbal et al. [19]	"Enhancing the low quality images	Unsupervised Color Correction Method	Enhanced Illumination and

		using Unsupervised Color Correction Method"	(UCM)	Contrast
2012	bt. Shamsuddin et al. [20]	"Significance level of image enhancement techniques for underwater images"	Based on Color Diminished and Stretched	Having better marine imaging applications
2016	C. Li et al. [10]	"Underwater Image Enhancement by Dehazing with Minimum Information Loss and Histogram Distribution Prior"	Underwater image dehazing algorithm	Minimization of information loss of enhanced underwater images and increased contrast and brightness.
2008	Fr´ed´eric Petit et al. [7]	"Underwater image enhancement by attenuation inversion with quaternions"	Underwater image enhancement using quaternions	Improved contrast and color dynamic
2013	Rashmi et al. [12]	"Algorithm and Technique on various edgedetection: A survey"	Prewitt operator Canny Operator Marr-Hildreth	Canny operator proves to be the best
2016	S. Tania and R.Rowaida [15]	"A Comparative Study of Various Image Filtering Techniques for Removing Various Noisy Pixels in Aerial Image"	Mean filter Median Filter Weiner Filter Wavelet transform	Median filter performs the best
2002	R. Eustice et al. [8]	"Underwater image toolbox for optical image processing and mosaicking in matlab"	Contrast limited adaptive histogram specification (CLAHS)	Contrast Enhancement

CHAPTER-3

PERFORMANCE METRICES

Mean Square Error(MSE)

MSE is defined as the cumulative squared error between the resultant image and the original image. MSE is given by:

$$\frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j)-K(i,j)]^2$$

where I_1 (m,n) and I_2 (m,n) represent the raw and improved images, respectively; and M × N denotes the size of the image, whereas m and n indicate the x and y locations of the pixel of the image, respectively.

Peak Signal to Noise Ratio(PSNR)

PSNR is defined as the ratio of the maximum possible signal and the noise. PSNR is given by:

$$10\log_{10}[\frac{(2^B-1)^2}{MSE}]$$

where B represents the bits per sample.

CHAPTER-4

IMAGE ENHANCEMENT TECHNIQUES

4.1) INTRODUCTION

The image enhancement method is mainly used to analyse the raw image and then process that image so that the quality of output image is better as compared to the input raw image [2]. With the help of these techniques, we can enhance the images and the quality of the images can also be improved for processing further. It also highlights various interesting details in images and also helps in making images more visually appealing. Various enhancement methods are available for improving the contrast of the image. These include simple contrast stretching techniques, filtering and also image transforms [5]. The most common techniques include global histogram equalisation and histogram specification which helps in making the histogram of an image uniform over all intensity levels and follow a specific pattern [2].

4.2) LITERATURE REVIEW

Various authors have worked on improving the quality of images. Many image enhancement methods have been implemented. In [1], the authors have proposed a technique based on slide stretching for improving the visibility of underwater images. In [2], the authors have proposed a technique to improve the low contrast of images. A software is designed for enhancement of the images using contrast stretching technique on RGB and HIS digital image color space. In [3], the authors have proposed a technique for improving the existing homomorphic filtering. In [4], the authors proposed a technique to enhance the quality of underwater images using stretching process followed by the Rayleigh distribution. In [7], the authors have proposed a technique for underwater image enhancement using quaternions.

4.3) PROPOSED METHOD

We have worked on two underwater image enhancement techniques namely Contrast Stretching and Homomorphic Filtering and then analysed which technique works better.

4.3.1) Contrast Stretching

The contrast stretching algorithm is used to upgrade the contrast of the image. It is done by expanding the range of the colour values to utilise all conceivable values. The contrast stretching algorithm uses the linear scaling function to the pixel values. Each pixel is scaled using the following function:

Po = (Pi– c) x (b – c) / (d – c) + a

“Where, Po is the nrml Pxl Val; - Pi is the considered Pxl Val; - a is the min Val of the desired range; - b is the max Val of the desired range; - c is the lowest Pxl Val that is present in the image; - d is the highest Pxl Val that is present in the image.

In the second step, the RGB image is changed to HIS with the assistance of saturation and intensity transfer function. This makes a difference in expanding the true colour and brightness of underwater images.

The saturation and intensity values of HSI colour model can be expanded with the assistance oftransform function. Saturation parameter tells the true color of underwater images. The HSI model also helps in solving the lighting problem with the use of Intensity parameters.The process is given in the figure 19

Figure 19: Contrast Stretching Algorithm Method [1]

4.3.2) Homomorphic Filtering

Homomorphic filtering method is used for image enhancement. It adjusts the brightness across an image andincreases the contrast. It helps in removing multiplicative noise. As we know that illumination and reflectance are multiplicative, so it is important to make the component additive. This is done by taking the logarithm of the image intensity.This helps in separatingthe multiplicative components linearly in the frequency domain. Since change in illumination is a type of multiplicative noise so it can be reduced by filtering in the log domain.
The illumination of an image can be made more even only if we increase the high-frequency components and decrease the low-frequency components. High-frequency components shows the reflectance in the scene whereas the low-frequency components show the illumination in the scene. We use high pass filter as itsuppresses low frequencies and amplifies the high frequencies, in the log-intensity domain which is required.The process is given in the figure 20

Figure 20: Homomorphic Filtering

4.4) EXPERIMENTAL RESULT AND ANALYSIS:

- Performance analysis using contrast stretching method:

S.no.	MSE	PSNR
IMAGE 1 (7.jpg)	0.0092	44.4147
IMAGE 2 (a.jpg)	0.0124	43.1307
IMAGE 3 (s.jpg)	0.0088	44.6384
IMAGE 4 (5.jpg)	0.0089	44.5487
IMAGE 5 (xyz.jpg)	0.0114	43.5084

Table 5: Performance analysis using contrast stretching method

- Performance analysis using homomorphic filtering method:

	Sigma values	MSE	PSNR
IMAGE 1 (7.jpg)	Sigma 1=0.1	0.0080	45.0309
	Sigma 2=0.4	0.0074	45.3697
	Sigma 3=0.8	0.0032	49.0558
IMAGE 2 (5.jpg)	Sigma 1=0.1	0.0066	45.8460
	Sigma 2=0.4	0.0061	46.2178
	Sigma 3=0.8	0.0026	49.9227
IMAGE 3 (a.jpg)	Sigma 1=0.1	0.0078	45.1486
	Sigma 2=0.4	0.0070	45.6406
	Sigma 3=0.8	0.0023	50.4192
IMAGE 4 (s.jpg)	Sigma 1=0.1	0.0072	45.4694
	Sigma 2=0.4	0.0067	45.7833
	Sigma 3=0.8	0.0032	49.0598
IMAGE 5 (xyz.jpg)	Sigma 1=0.1	0.0097	44.2105
	Sigma 2=0.4	0.0090	44.5446
	Sigma 3=0.8	0.0036	48.5007

Table 6: Performance analysis using homomorphic filtering method

SNAPSHOTS:

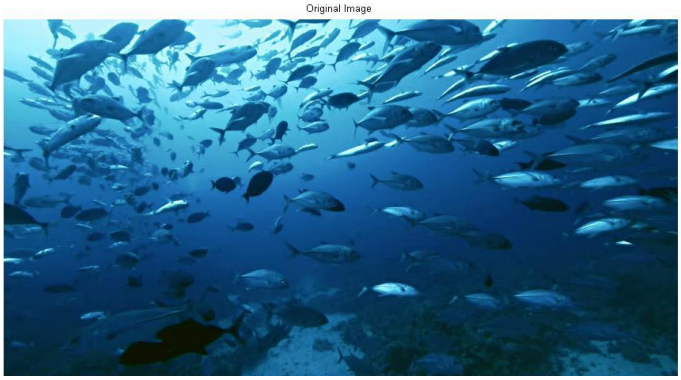


Figure 21(a): Original Image

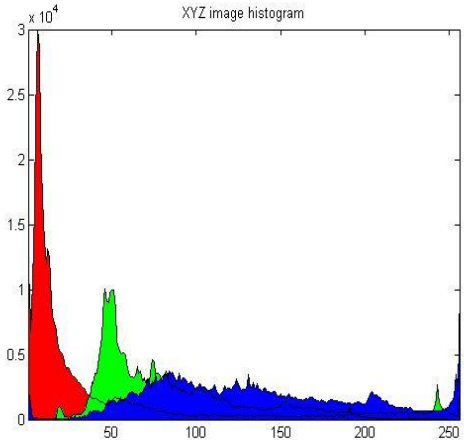


Figure 21(b):Histogram after Contrast Stretching

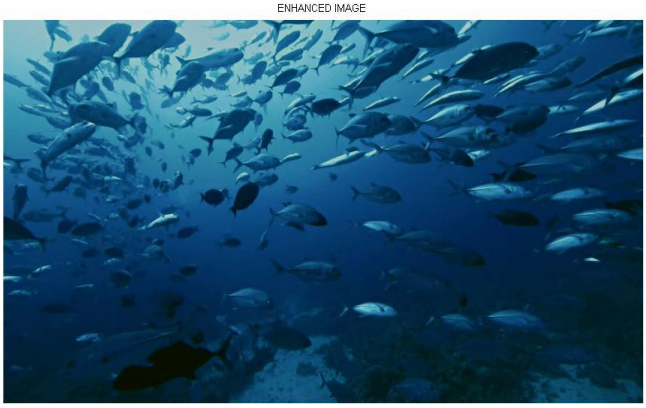


Figure 21(c): Enhanced Image

Figure 22: Image before and after Homomorphic Filtering

4.5) CONCLUSION

- By analysis of the following results, we can conclude that the homomorphic filtering technique gave lesser values of PSNR for the tested images. Hence contrast stretching technique is better.
- Further we observed that on increasing the width of the Gaussian filter the value of PSNR also increases. Hence for better result the value of the width of filter should be low.
- Further we observed that the bluish tinge in the images was also reduced and the images were colour corrected.

CHAPTER-5

ANALYSIS OF EDGE DETECTION TECHNIQUES BEFORE AND AFTER NOISE REMOVAL

5.1) INTRODUCTION

The process of object detection incorporates loading an image, processing the image, filtering and scaling of the image to find the object [10]. Currently to detect underwater submarines, sonar technique is used. The main objective of Object Detectionis to recognize objects without any of the work done by humans [12].

With the help of edge detection, sharp discontinuities can be located and easily identified in an image. The discontinuities are sudden changes in pixel intensity which tells the boundaries of objects in a scene. Edge detection is required in various systems like vision systems and object recognition systems. There are a large number of edge detection operators which exist and each of them is designed to be sensitive to certain types of edges [13]. Edge detection is done on the basis of various variables namely Edge orientation, Noise environment and Edge structure. It is still a difficult task to find true edges in an image. As we know that the noise and the edges have high frequency content, so edge detection is difficult in noisy images. Attempts to reduce the noise result in blurred and distorted edges [15].

5.2) LITERATURE REVIEW

Various authors have proposed edge detection and noise removal techniques. In [12], the authors have surveyed some edge detection techniques such as Prewitt, Robert, Sobel, Marr- Hildreth and Canny operators. In [14], the authors have discussed the various types of noise that can creep into the images during acquisition, transmission, or retrieval from storage media. In [15], the authors have proposed the technique to remove the noise from the image and then each filter is compared so as to find out which filter works better with which type of noise.

5.3) PROPOSED METHOD

We have worked on three edge detection methods namely, Canny operator, Prewitt operator and Marr-Hildreth. We have applied three types of noise on our images namely, Gaussian noise, Salt and pepper noise and Poisson noise. Further we have used homomorphic filter, combination of mode and median filter, combination of mode and bilateral distributive filter and combination of median and bilateral distributive filter for removing the noise. After the implementation, the results have been analysed and compared.

5.3.1) Canny method

- Smooth the image by applying Gaussian filter in order to evacuate the noise
- Find the concentrated slopes of the image
- Apply non-maximum suppression to the gradient magnitude and then apply double limit to determine potential edges and then link the edges.

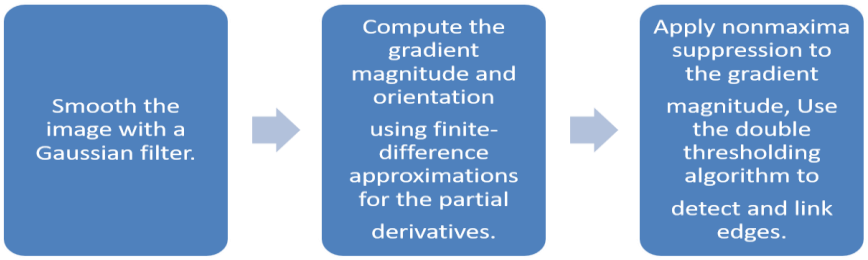


Figure 23: Flowchart showing canny edge detection method

5.3.2) Prewitt Operator

Prewitt operator is a discrete separation operator which computes an estimation of the slope of the image intensity function. The result of the Prewitt operator is either the corresponding gradient vector or the standard of this vector.

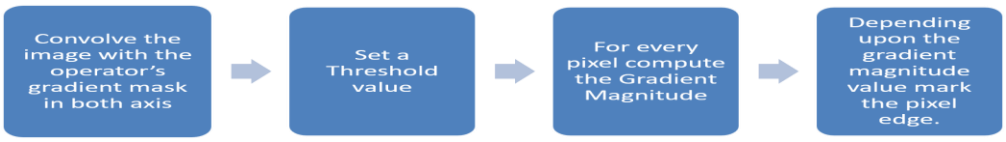


Figure 24: Flowchart showing Prewitt edge detection method

5.3.3) Marr-Hildreth Operator

The Marr–Hildreth edge detection strategy operates by convolving the image with the Laplacian of the Gaussian Function or as estimation by distinction of gaussians. At last, we check for zero crossings in the filtered image for obtaining edges.

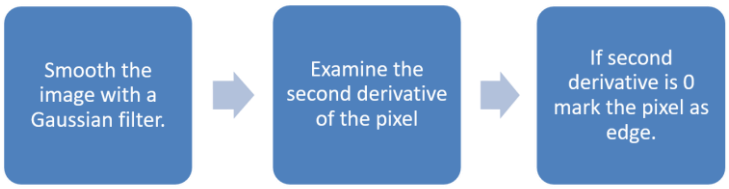


Figure 25: Flowchart showing Marr-Hildreth edge detection method

5.3.4) Homomorphic Filter

Figure 26: Flowchart showing algorithm for Homomorphic Filter

5.3.5) Combination of Mode and Median filter

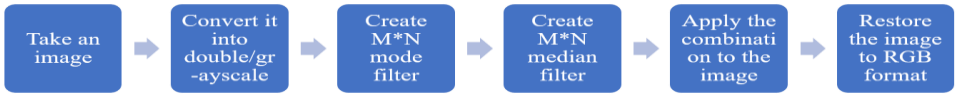


Figure 27: Flowchart showing algorithm for combination of Mode and Median Filter

- 5.3.6) Combination of Mode and Bilateral Distributive Filter

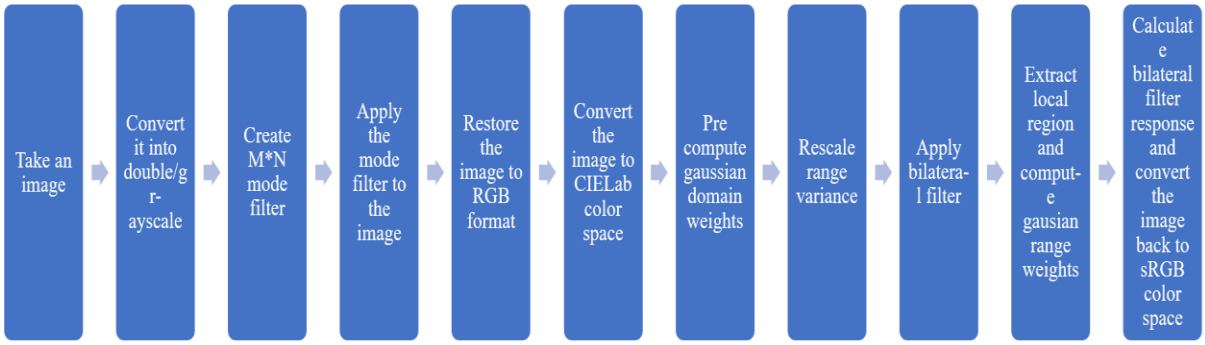


Figure 28: Flowchart showing algorithm for combination of Mode and Bilateral Distributive Filter

5.3.7) Combination of median and bilateral distributive filter

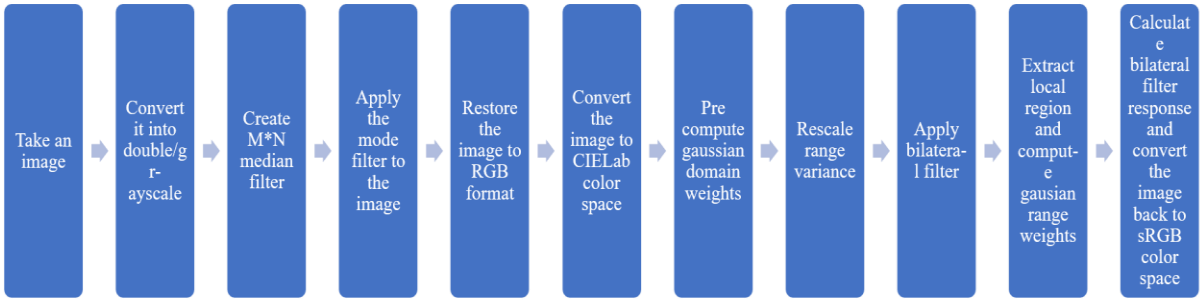


Figure 29: Flowchart showing algorithm for combination of Median and Bilateral Distributive Filter

5.4) EXPERIMENTAL RESULTS AND ANALYSIS:

- Comparison of quality of image before and after enhancement

S.no	Before Filtering		After Filtering	
	MSE	PSNR	MSE	PSNR
1.	13395	6.8614	649.8	20.0027
2.	8346	8.917	1457	16.4955
3.	4313	11.49	1502	16.362
4.	14566	6.4975	7466	9.399
5.	10632	7.8646	1600	16.087

Table 7: Performance analysis of quality of image before and after enhancement

- Comparison of quality of image when various filters are applied on the image affected by salt and pepper noise

S.no	When no filter was applied	Homomorphic filter	Combination of Mode and Median Filter	Combination of Mode and Bilateral Distributive Filter	Combination of Median and Bilateral Distributive Filter
	PSNR	PSNR	PSNR	PSNR	PSNR
1.	6.7721	11.0484	12.6523	12.6523	12.0748
2.	1.7635	14.3602	16.7608	16.7725	15.6263
3.	10.2576	14.7342	15.6799	16.3317	15.8048
4.	8.4333	13.0470	14.8906	15.3190	14.6799
5.	2.4681	17.3638	17.4721	17.8675	17.2874

Table 8: Performance analysis of quality of image when various filters are applied on the image affected by salt and pepper noise

- Comparison of quality of image when various filters are applied on the image affected by Gaussian noise

S.no	When no filter was applied	Homomorphic filter	Combination of Mode and Median Filter	Combination of Mode and Bilateral Distributive Filter	Combination of Median and Bilateral Distributive Filter
	PSNR	PSNR	PSNR	PSNR	PSNR
1.	6.7721	11.1037	12.6437	12.7245	12.0904
2.	1.7635	14.5251	16.8981	16.9191	15.6226
3.	10.2576	14.9965	15.9939	16.5090	15.8409
4.	8.4333	13.0441	15.0996	15.4553	14.8241
5.	2.4681	17.4402	17.5368	17.9200	17.3100

Table 9: Performance analysis of quality of image when various filters are applied on the image affected by Gaussian noise

- Comparison of quality of image when various filters are applied on the image affected by Poisson noise

S.no	When no filter was applied	Homomorphic filter	Combination of Mode and Median Filter	Combination of Mode and Bilateral Distributive Filter	Combination of Median and Bilateral Distributive Filter
	PSNR	PSNR	PSNR	PSNR	PSNR
1.	6.7721	11.0516	12.6698	12.7107	12.0545
2.	1.7635	14.5707	16.8638	16.9308	15.6354
3.	10.2576	15.0312	16.0390	16.5566	15.8788
4.	8.4333	13.1285	15.0771	15.4744	14.7425
5.	2.4681	17.4217	17.5757	17.9508	17.3050

Table 10: Performance analysis of quality of image when various filters are applied on the image affected by Poisson noise

- Comparison of quality of image when various filters are applied on the image affected by combination of Salt and Pepper noise, Gaussian noise, Poisson noise

S.no	When no filter was applied	Homomorphic filter	Combination of Mode and Median Filter	Combination of Mode and Bilateral Distributive Filter	Combination of Median and Bilateral Distributive Filter
	PSNR	PSNR	PSNR	PSNR	PSNR
1.	10.2576	14.4470	16.0838	16.5591	15.7189
2.	1.7635	14.5353	16.9344	16.9204	15.5906
3.	2.4861	17.2101	17.5691	17.8614	17.0557
4.	8.4333	12.9581	15.1918	15.5955	14.7052
5.	6.6509	12.7675	13.8853	14.1825	13.6301

Table 11: Performance analysis of quality of image when various filters are applied on the image affected by combination of Salt and Pepper noise, Gaussian noise, Poisson noise

SNAPSHOTS:

Figure 30(a): Original Image

Figure 30(b): Image with salt and pepper noise

Figure 30(c): Image with gaussian noise

Figure 30(d): Image with poisson noise

Figure 30(e): Edge detected image Without filter

Figure 30(f): salt and pepper enhanced image using homomorphic filter

Figure 30(g): Edge detected image after Applying homomorphic filter to remove Salt and pepper noise

Figure 30(h): Edge detected image after applying combination of mode and median filter

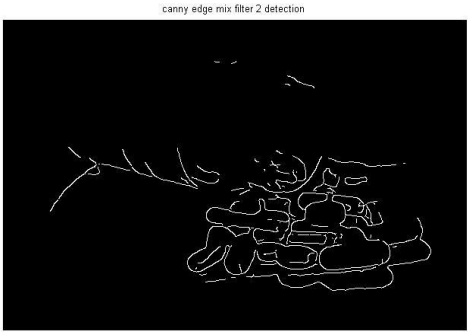


Figure 30(i): Edge detected image after Applying combination of mode and Bilateral filter

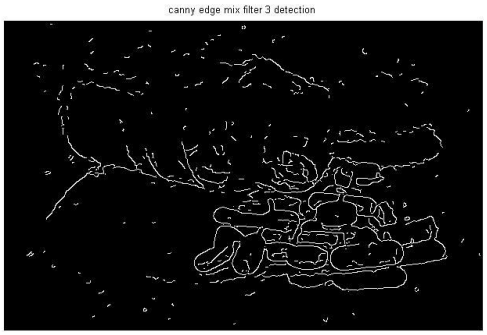


Figure 30(j): Edge detected image after applying combination of median and bilateral filter

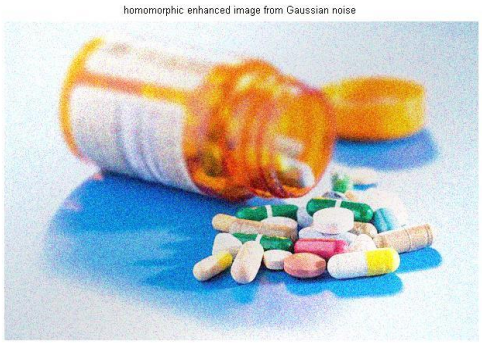


Figure 30(k): gaussian noise enhanced using Homomorphic filter

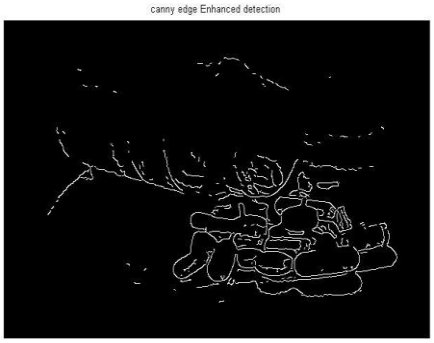


Figure 30(l): Edge detected image after applying homomorphic filter to remove Gaussian noise

Figure 30(m): Edge detected image after applyingCombination of mode and median filter

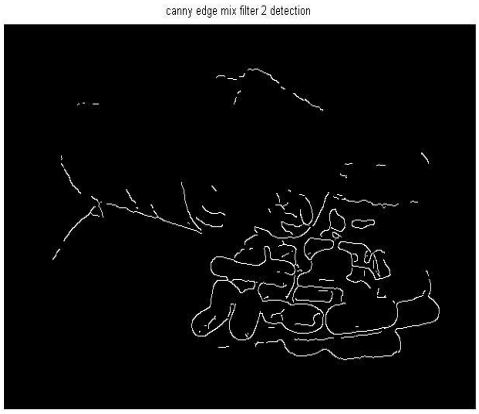


Figure 30(n): Edge detected image after applyingCombination of mode and bilateral filter

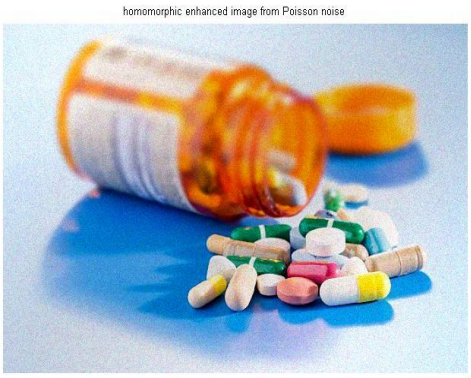


Figure 30(o): Poisson noise enhanced Image using homomorphic filter

Figure 30(p): Edge detected image after applying combination of mode and Median filter

Figure 30(q): edge detected image after Applying homomorphic filter

Figure 30(r): edge detected image after applying combination of median and Bilateral filter

Figure 31(a): original image With salt and pepper noise

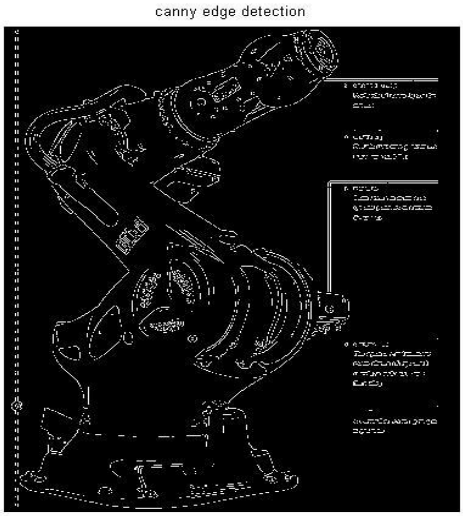


Figure 31(b): edge detected image using canny method

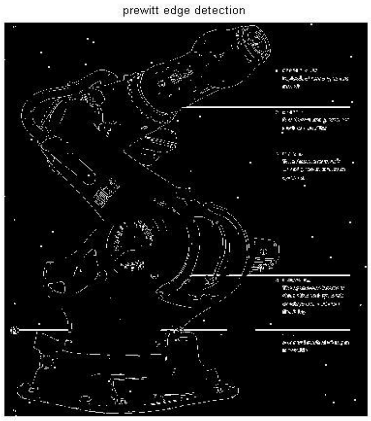


Figure 31(c): edge detected image Using prewitt operator with noise

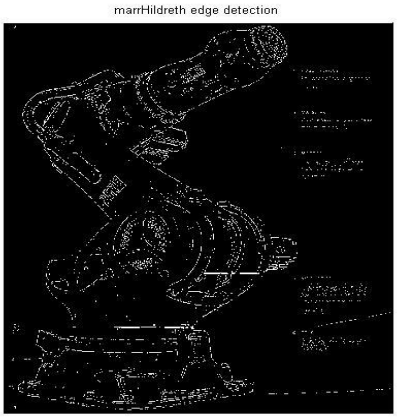


Figure 31(d): edge detected image using marr-hildreth operator with noise

Figure 31(e): enhanced image from Salt and pepper noise

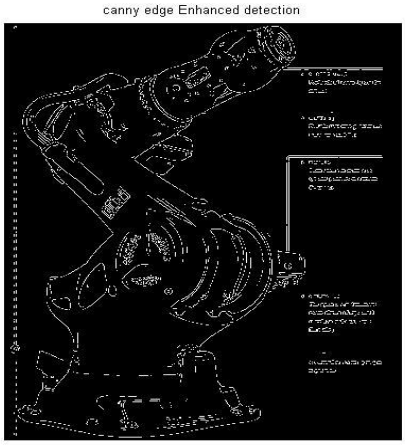


Figure 31(f): edge detected image using canny method with no noise

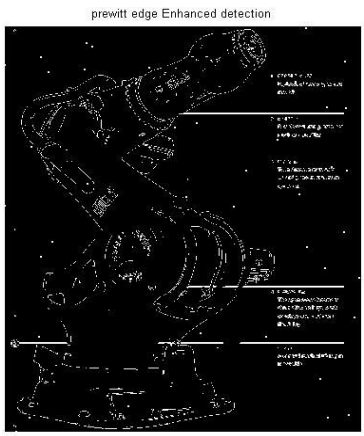


Figure 31(g): edge detected image Using prewitt operator

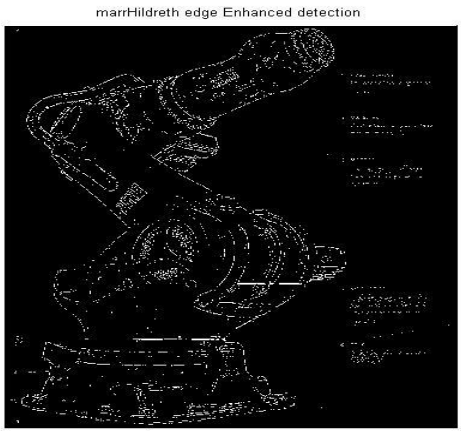


Figure 31(h): edge detected image using marr-hildreth operator

4.5) CONCLUSION

- On analyzing the result, we found that Canny edge detection works well with all the images as compared to Prewitt and Marr-Hildreth techniques.
- The quality of edge detected image when there was no salt and pepper noise was better than the image with salt and pepper noise. Hence edge detection techniques work well when there is no noise in the system.
- The combination of mode and bilateral distributive filter works better as compared to the combination of median and mean filter and also median and bilateral distributive filter. It also helps in improving the performance of the existing system.

CHAPTER-6

CONCLUSION AND FUTURE SCOPE

6.1) CONCLUSION

- By analysis of the following results, we were able to conclude that the homomorphic filtering technique gave lesser values of PSNR for the tested images.
- Further we observed that on increasing the width of the Gaussian filter the value of PSNR also increases. Hence for better result the value of the width of filter should be low.
- Further we observed that the bluish tinge in the images was also reduced and the images were colour corrected.
- On analyzing the result, we found that Canny edge detection works well with all the images as compared to Prewitt and Marr-Hildreth techniques.
- The quality of edge detected image when there was no salt and pepper noise was better than the image with salt and pepper noise. Hence edge detection techniques work well when there is no noise in the system.
- The combination of mode and bilateral distributive filter works better as compared to the combination of median and mean filter and also median and bilateral distributive filter. It also helps in improving the performance of the existing system.

6.2) FUTURE SCOPE

- A considerable challenge for future eras is to create imaging frameworks that can eliminate the forward scatter, whereas at the same time, imaging either a volume (through temporal flag extend handling) or a straightforward 2-D picture, about instantaneously.
- There is no question that the proceeded expansion of higher execution, less costly innovation with the electro-optical commercial centre will proceed, profiting the submerged imager of more choices, at less fetched.
- Last, perhaps indeed quantum material science can be used for further detecting to extend submerged optical imaging framework performance.
- Among the various filters used, none of the filter proved to be much better than others in termsof computation cost, noise removal and improvement in the image quality. Because of this noise removal methods are still to be improved and investigations and research can be performed.
- Improvement in canny algorithm so that it can be used to detect edges in color image also without the image being converted to gray scale for processing.

CHAPTER-7

INTRODUCTION TO SIMULATION TOOLS

7.1) SOFTWARE USED: MATLAB

MATLAB (matrix laboratory) is a multi-archetype numerical computing environment. It is a restrictive programming language which was created by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python**.**

MATLAB was primarily designed for numerical computing, allowing access for symbolic computing applications but later many toolbox and packages were included to extend the functionality of MATLAB. Those Packages includes Image Processing Toolbox, Automation Toolbox etc.

7.2) PREDEFINED FUNCTION IN MATLAB LIBRARY

- Imread () - This converts the digital image into a 3D vector and gives us the pixel values of the image in RGB format. It makes us easy to continue our work on the image like - enhancement , modification or removal of noise.

- rgb2gray() - This function converts RGB image into agray image. This function is usually faster than the manually written ones. And our aim was to modify the image so it was a better choice to use the inbuilt rgb2gray function for good speed.

- Prewitt() - this function is used for prewitt edge detection technique. It was a simple filter which could be applied easily on an image and is available in Image Processing Toolbox. There was not much difference in the manually written code and the predefined version in terms of performance. So, we decided to choose the already available function to decrease the extra lines of code.

7.3) MANUALLY WRITTEN FUNCTIONS

- mode filter - This filter is a simple implementation of the mode filter used for the removal for salt and pepper noise.

- median filter - This filter is implemented in a similar manner like mode filter. It is used for removing gaussian noise. Both filters are made using basic loops and if statements.

- Combination of mode and median filter - It is created by mixing median and mode filter. This filter is a modified filter used for removing multiple noises simultaneously.

- Combination of mode and bilateral distributive filter - It is created by mixing median and bilateral filter. This filter is again a modified filter used for removing multiple noises simultaneously.

- Combination of median and bilateral distributive filter - It is created by mixing bilateral and mode filter. All these 3 filters are created for the testing purposes so that we can check which combination works in a better way. They are implemented by simply merging the respective filters using either a loop or by if statements.

- PSNR and PSNR_GREY : These are the mathematical functions written for finding the PSNR for RGB and GrayScale images. We implemented the mathematical formula of PSNR so that it can be used for colored and grey images. They are implemented by using simple mathematical functions provided by MATLAB.

CHAPTER-8

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