Chapter 1 INTRODUCTION

1. INTRODUCTION

1.1 Image

When an object like, person, thing, scene, etc are presented in visual form known as image. Images could be 2D or 3D depending on the frames captured and projections are maintained. 2D images are still images and 3D images are combination of many 2D images at many projection levels and angles [1]-[6].

1.1.1 Image File Formats

It is used to symbolize bitmap images consist of a file header which store information regarding the image. Image information like as figure altitude and size, number of bits for every pixel, number of bands and various signature bytes representative the heading type. It can also include information regarding to the variety of density used and different limitations to be requisite to translate the picture during the more convoluted file formats [7] [8].

These are mainly necessary for cameras, printing, scanning, also internet use such as:

- ✓ JPEG
- ✓ GIF
- ✓ BMP
- ✓ PNG
- ✓ TIFF

1.1.1.1 JPEG

This file format stands for Joint Photographic Expert Group. It is popular for the photographic quality image representation. Since most of the information is left out in this format therefore JPEG format files are ‘Lossy’ in nature. The format keeps the minimum information to generate and save the JPEG files. The JPEG format files requires less memory to store images but with the compromise of quality to certain extent.

Figure 1.1(a) & (b) shown, image density is not to facilitate observable at primary glance. But with a earlier glance the artefacts can be clearly observed like any other JPEG image.

Figure1.1(a): Original figure

Figure1.1(b): JPEG figure

Also, the acuteness of image of JPEG is not same like of the unique figure. The JPEG contains noises in form of pale colors are paler and the less defined lines as compared to the original one.

Merits of JPEG:

- Works with up to 16 million colors, 24-bit color
- Well suited for images with fine color effects requirements
- Most commonly used image format
- Compatible with almost all OS including the major ones like (Mac, PC, Linux)

Limitations of JPEG:

- The format is prone to discard considerable amount of information from the original image
- Artifacts do likely to exist after compression in JPEG formats
- Animation not possible
- 1Transparency not allowed

1.1.1.2 GIF

It stands Graphics Interchange Formats which is intended by CompuServe during the early days of computer 8 bit video, earlier than JPG, for video exhibit next to dial up modem speeds. GIF is still an admired picture design on the internet because picture dimension is comparatively little compared to other figure density types. The lossless LZW compression

is used by GIF format [7], but it is not good for 24-bit color images since it an indexed color filed which supports maximum of 256 colors. Therefore indexed color file is not recommended to use for color images because of the limited colors.

Figure 1.2: GIF Image

Merits of GIF:

- Can sustain transparency
- Minute Animation effects is allowed
- Lossless quality contain quantity of quality are similar to the original image, apart from a way it has only 256 colors.
- Enormous intended for imagery with restricted colors, or with plane regions of color.

Limitations of GIF:

- Supports simply 256 colors
- This format is the previously used to inside the network, having subsisted since 1989. It has not been well-run since, and occasionally, GIF files are larger than PNG.

1.1.1.3 BMP

Microsoft windows operating system contained BMP files as image files. BMP files are uncompressed, other than the imagery are inside high value, well-off color, effortless and well-suited for windows OS and programs. When image files are created millions of dots

known as BMP files and these dots are called “pixels”. It obliges an 8-bit, 16 bit or 24-bit images.

Thus when we make BMP figure larger or minor, we are assembly the entity pixels large.

Figure 1.3: BMP Image

Merits of BMP:

- Friendly with windows programs and OS, we know how to use it like a windows wallpaper

Limitations of BMP:

- Does not extent or reduce well
- Again, extremely enormous figure files creation it not system friendly.

1.1.1.4 PNG

Portable Network Graphics (PNG) is a latterly introduced format. A picture layout explicitly intended for the mesh.PNG. It is saved with maximum 256 colour pixels excluding it saves the colour in sequence more economically. It besides represent a 8 bit simplicity [7] [8].

Figure 1.4: PNG image

Merits of PNG:

- It does not lose excellence along with indicate behind figure density known as Lossless.
- PNG habitually creates lesser file sizes than GIF.
- PNG sustains simplicity enhanced than GIF.

Limitation of PNG:

- It is not superior for outsized imagery because they are likely to produce awfully huge file, occasionally create well-built records than JPEG.
- PNG cannot be animated.
- Web browsers cannot support PNG.

1.1.1.4 TIFF

It stands Tagged Image File Format (TIFF). It was produced by Aldus for 'desktop publishing', and by 2009 it to be transfer to the control of Adobe system.TIFF is trendy with ordinary users, except it has gain acknowledgment in the graphic design, publishing and picture making trade. It is too admired with Apple users. This layout is graceful to utilize by software to facilitate trade among page design, distributing as well as picture management using fax, scanning, word processing, etc.

TIFF is especially negotiable, and it preserve be lossless. It is a dynamic layout with support through several imaging programs. This format is resourceful of footage halftone picture information by special pixel intensities, therefore be the great designed for detailed storage, dispensation and printing. It is also greater raster figure layout.

Figure 1.5: TIFF image

Merits of TIFF:

- It is extremely lithe layout. It ropes some kind of density resembling JPEG, LZW, and ZIP.
- It stored all color and data information with high quality image format
- At present this configures preserve to be kept through levels.

Limitation of TIFF:

a) It has slow loading time, extremely large file size-long move time, and enormous disk space expenditure.

TABLE 1.1: Comparison among Different Image Formats

Common Format	Description / Properties	Archive Recommendations
TIFF (.tif / .tiff)	Tagged Image File Format (Adobe) Uncompressed image format. it can preserve range of metadata: EXIF, GeoTIFF for georeferencing	TIFF Version 6 standard format for extended word conservation of digital figures in uncompressed.
JPEG (.jpg / .jpeg)	It is Joint Photographic Expert Group by ISO standard 32-bit colour depth with very well-organized lossy compression. Image Compression creates 'evident artefact' about complex high-contrast image areas (e.g. text) . It can Supports EXIF and IPTC metadata.	While inappropriate for long term storage, accepted format for archiving digital photographs considered for graphic or painted images with smooth varying tones that do not have sharp contrast. Smaller file sizes than PNG or TIFF. it is outdated by lossless compression JPEG2000
JPG(.jp2 / .jpx)	In the compression of images .jpx format is to be intended to replace .jpeg Higher performance by JPEG2000 ISO standard. Lossless compression JPX format use XML to accumulate metadata, and ropes IPTC and Dublin Core metadata, but it is not support EXIF.	In the standard JPEG2000 will most likely become well liked format use. Earlier preservation but, not yet contained by internet browsers. It is not support digital camera manufacturers.
PNG(.png)	In ISO standard Lossless compression, Portable Network Graphics contained 32-bit colour depth. And few 'visible artefacts' Does not support metadata like EXIF.	In lossless presentation, is designed for internet. It uses RGB colour space Standard format and as a substitute GIF format Some data centres do not suggested for PNG earlier storage (use TIFF). It is only supports RGB colour for digital photographs.

1.2 Digital Image

When images are processed in computer they are regarded as digital images, they could be color, gray scale images. Each image is made up of pixel which is equal to the product of height and width. Every pixel has an integer value of which demonstrates the intensity or visibility of that pixel; this value varies between 0-255.

Type of Images:

- Binary Images (1-Bit)
- Gray Images (8-Bit)
- Color Images (24-Bit)

1.2.1 Binary Image

Binary representation are determined like a 2D array, normally by 1 bit per pixel, where a 0 ordinary indicate "black" and a 1 represents "white" (even if here is no worldwide contract on that). The most important benefit of this image generally appropriate for picture restraining easy graphics, passage or line painting is its tiny amount. Figure 2 explain a binary picture (the effect of an edge recognition algorithm) along with a 6 × 6 elaborated a state, where pixels by a significance of 1 represent to limits and pixels by a significance of 0 represent to the environment.

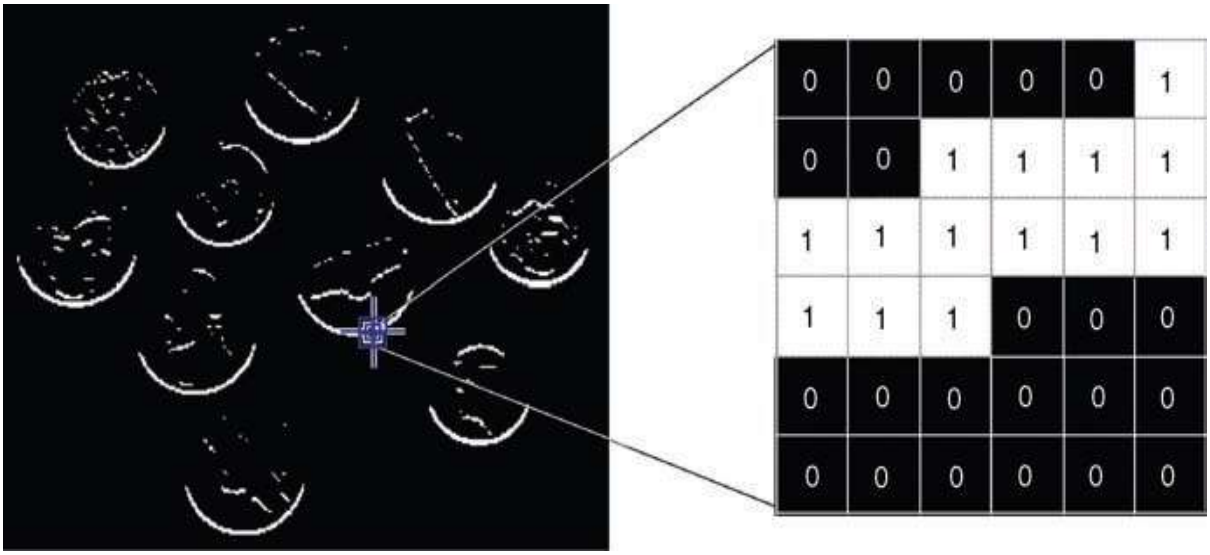


Figure 1.6: Binary (1-Bit) picture Pixel layout [8]

1.2.2 Gray Image

Gray-level (as well referred toward like *monochrome*) representations are too determined like a 2D arrangement of pixels, generally through 8 bits per pixel, wherever a pixel impact of 0 write to “black,” a pixel impact of 255 denotes “white,” with the moderate standards designate unreliable darkness of gray. The entire quantity of gray intensity is better than the person illustration scheme supplies (which, into the majority of cases, cannot understand some enhancements outside to 64 gray altitudes), creating this design a superior cooperation involving personal illustration worth and comparatively solid illustration and storage.

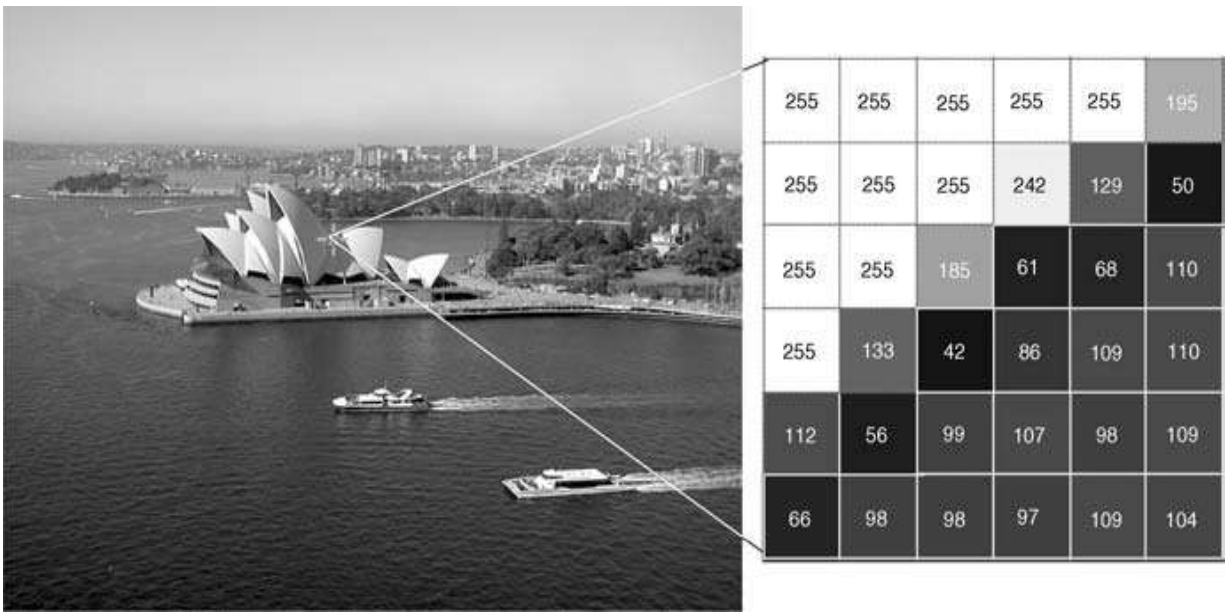


Figure 1.7: Gray-Scale (8-Bit) Image Pixel Format [8]

1.2.3 Color Image

Color image representation is more difficult and different. The two mainly common methods of accumulate color picture enclose are RGB symbol inside which every pixel is typically constituted through a 24-bit integer surrounding the quantity of its red (R), green (G), and blue (B) mechanism as well as indexed account anywhere a 2D arrangement include index to a color light (or search for chart - (LUT)).

RGB Color pictures (24-bit):

Color picture capable of symbolize via three 2D array of equal amount, single used for every color sound: red (R), green (G), and blue (B). Every collection of element holds an 8-bit rate

representative the quantity of red, green, or blue at so as to position in a [0, 255] range. A reserve symbol use 32 bits for each pixel with consist of a fourth channel, known as the alpha channel to facilitate supply a evaluate of simplicity used for every pixel and is commonly worn in picture editing property [5].The blend of the three 8-bit standards keen on a 24-bit digit permits 224 (16,777,216, generally submitted to like 16 million or else 16 M) color arrangement.

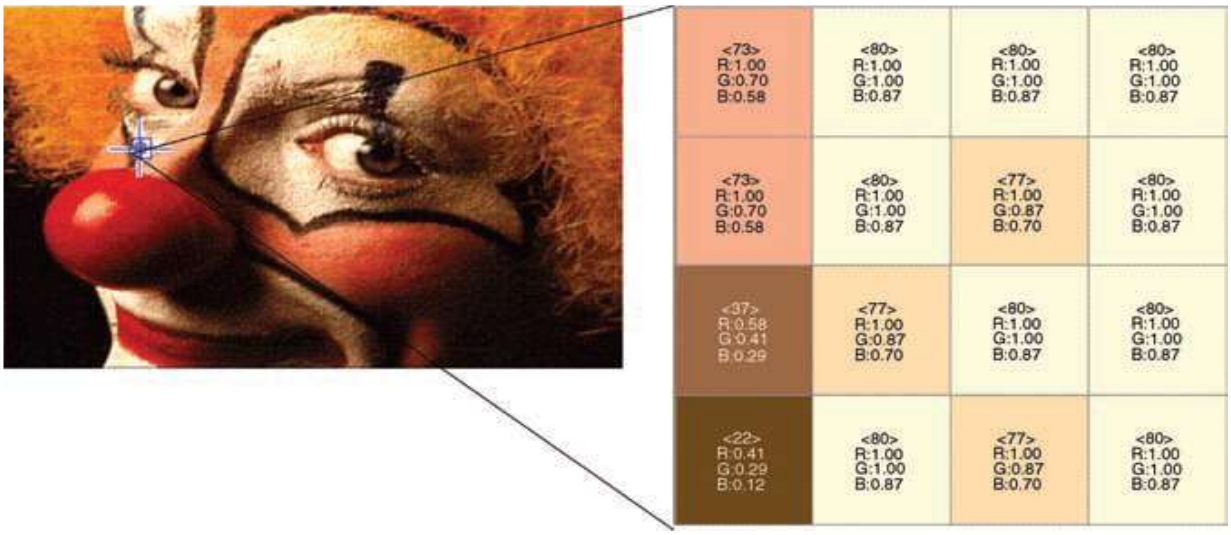


Figure 1.8: Color (24-Bit) Image Pixel Format [8].

Indexed Color Images:

In this, color representations (24-bit color), a problem occurs which is backward well-suited by older hardware to might not be able to present the 16 million colors concurrently. Solution of this problem that created prior to 24-bit color presents with record cards be usually accessible consisted of a key illustration, wherein a 2D collection of the equal range like as the figure enclose directories (indicators) in the direction of a color map (or light) of preset utmost range (generally 256 colors). It is only support record of colors worn in to the picture.

Color Formats:

- 24 bit RGB
- CMYK
- HSB

1.2.3.1 24 bit RGB

In this color image model represents R shadow of Red, G shadow of Green, B shadow of blue. Each shade of RGB representation every color is symbolized through an integer series as of 0 to 255. The black color is delineated using the '0 0 0' RGB significance (R=0, G=0 and B=0) even as the white color is symbolize with the '255 255 255' RGB significance (R=255, G=255, B=255). Thus the RGB representation can signify additional than 16 millions of colors. This model is also called stabilizer representation because additive colors (Red, Green and Blue) are compounded and make white color.

White = Red + Green + Blue.

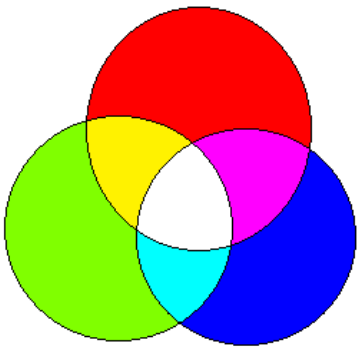


Figure 1.9: Graphic representation of 24 bit RGB Color

1.2.3.2 CMYK

In color representation CMYK stands **C**yan **M**agenta **Y**ellow Blac**K.** This model used 4 color inks inside of color printers and printing color data. It is also called Subtractive model. According to premise Cyan, Magenta and yellow ought to merge with themselves to understand all colors and generate black. Although because of this area of the dirtiness establish in little amount for all inks, they really merge and create a muddy brown color so that is the single motive used for the black ink. In advances basis colored inks are costly as compare to the black ink.

For the duration of printing the color of 3 inks indicates 3 coating with these coatings basis in the printed paper to be converted into fairly damp, because of this reason document resolve dried out extra gradually with the push be able to be leisurelier.

We have to be bothered regarding CMYK color layout if we want to print something.

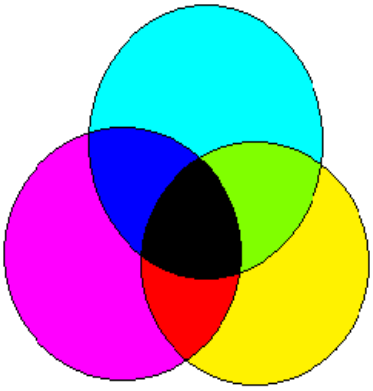


Figure 1.10: Graphics representation of CMYK color model

1.2.3.3 HSB

In this model, H stands for Hue, S stands for saturation and B stands for Brightness. In this, any color is represented by 3 numbers are: Hue, Saturation and Brightness. The initial quantity is the hue and its cost variety as of 0 to 360 degrees. Each degree represents a discrete colour. Initial convenient is the red colour (0 or 360 degrees) with after that convenient be every prior colours. The next integer is the dispersion. This model is represents the quantity of colour or its fraction is more precisely. This significance variety as of 0 to 100, here 0 correspond to no colour, although 100 correspond to the full colour. At last, the third integer is the brightness.

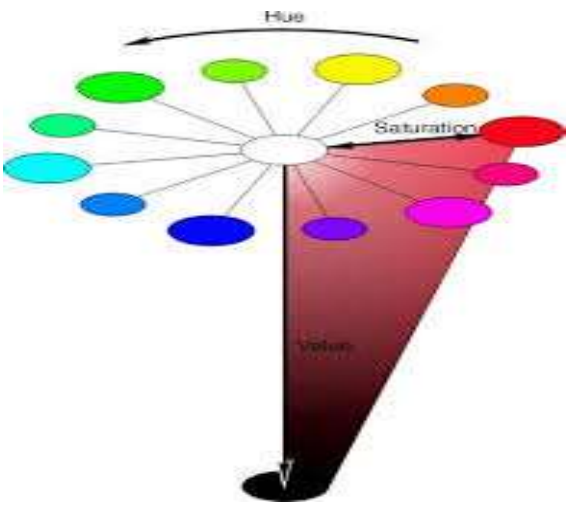


Figure 1.11: Graphics representation of HSB color model

We preserve increase the colour intensity count the white colour; otherwise we can able to ease it accumulation the black colour. This case 0 symbolize the white colour and 100 be the black colour.

1.3 Digital Image Processing

Images are stored in the computer and processed nearby for a lot of reasons; together computer and image are in digital form so the processing done on images using the computer are known as digital image processing. Processing could be sharpening the image, removing noise, transforming image formats, compress image, and transfer over network, increasing visibility or intensity of image, rotating image, cropping image, etc[8]-[11] .

Different stages of Image processing functions:

- ✓ Low Level: Noise Reduction, Contrast Enhancement
- ✓ Medium Level: Attribute Removal (limits, shapes, states)
- ✓ High Level: Examination and Explanation of the contents of a picture

1.4 Working of Digital Picture Processing Scheme

There are two types of element in Digital Image Processing; one for acquisition (image capture) and another for processing and displaying, it could be hardware or software or grouping of both.

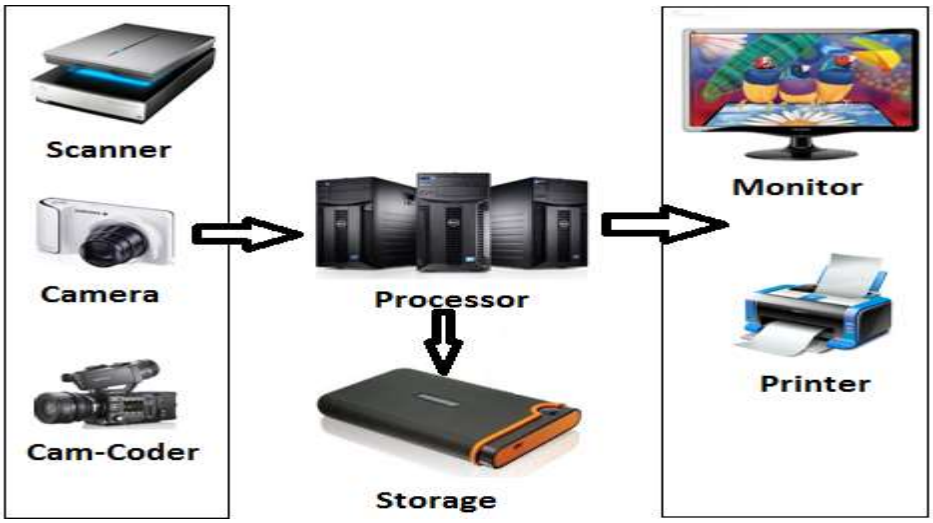


Figure 1.12: Digital Image Processing Components

Acquisition Capture from real world: This gadget is liable for digitizing and capturing pictures or record order. Example of general-purpose acquirement procedure comprises scanners, cameras, and camcorders. Achievement policy preserves to be interfaced by the major processor inside an integer of behavior, according to example USB, Camera connect, FireWire or Ethernet. Within cases anywhere the cameras generate analog capture output, a figure numeral typically identified like edge seizer is worn to renovate it to digital system.

Processing Tools: This equipment is dependable for organization of software to permits the dispensation with examination of obtains figures.

Display Procedure: This device liable for demonstrating the picture substances for person visioning. For example color observes and printers.

Storage Devices: Optical disks liable for lasting storage space of the pictures.

1.5 Type of Noise

Unwanted signal which gets embedded in the unusual signal is known as noise. In images the undesired value in the intensity of pixel is added is measured as noise. Noise can blur the images or can raise the contrast of the image, which is not enviable in the original image and image relocate [1] [2] [3] [4] [5] [6] [8] [12].

Noise at some pixel can be revealed with the below specified formula:

$$N = I_{PN} - I_{PO}$$

: Here PO for the Pixel Original and PN for the Pixel Noised Image and I denotes the intensity at that particular pixel.

Noise is a scalar value which is randomly generated and can't be calculated before the generation of it. This value is measure in the form of SNR, MSE, and PSNR and plotted in graph, histogram using the Probability Density Function. Noise may be positive or negative depending upon the variation occurred between noised and original image.

Different Type of Noise in image Processing

- Gaussian Noise
- Speckle Noise
- Poisson Noise
- Salt & Pepper Noise

TABLE 1.2: Programming Information used in MATLAB to Add Noise of Different Types

Value	Description
'Gaussian'	Gaussian noise with constant mean and variation
'Poisson'	Poisson noise
'Salt & Pepper'	Pixels are On and Off
'Speckle'	Multiplicative noise

1.5.1 Gaussian Noise:

Gaussian noise is described by the probability distribution or random fluctuation in a continuous physical process. It is also known as amplifier noise. Most important piece of the "read noise" of a figure antenna, to facilitate is, of the invariable noise plane in shady parts of the figure. The collective effect of all random noise generated over a period of time (it includes all frequencies) [3][8][12].

Figure 1.13 : (a) Original Image

Figure 1.13: (b) Gaussian Noised image

Gaussian noise affords a superior representation of noise within several figuring schemes and the probability density function for Gaussian Noise denoted as follows:

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

Linear average is the best method toward approximation the average value of a static arbitrary patchy in Gaussian Filter and this is considered as the most significant property of it.

1.5.2 Salt & Pepper Noise:

This noise is simply envisioned by human vision such as white & black dots occur in images arbitrarily. A figure including salt & pepper noise resolve have dark pixels in light areas and white pixels in dark areas.

Salt & pepper Noise be able to analytical describe by:

$$HISTOGRAM_{Salt\&Pepper} = \begin{cases} A & for\ g = a\ (\text{"}pepper\text{"}) \\ B & for\ g = b\ (\text{"}salt\text{"}) \end{cases}$$

-

There be simply two feasible principles, A and B, with the possibility of every pixels is normally a smaller amount than 0.2 by information better than this. Designed for an 8-bit figure, the usual importance for pepper noise is 0 “black colour”, and 255 for salt-noise “white colour”. It also called as impulse noise [3][12].

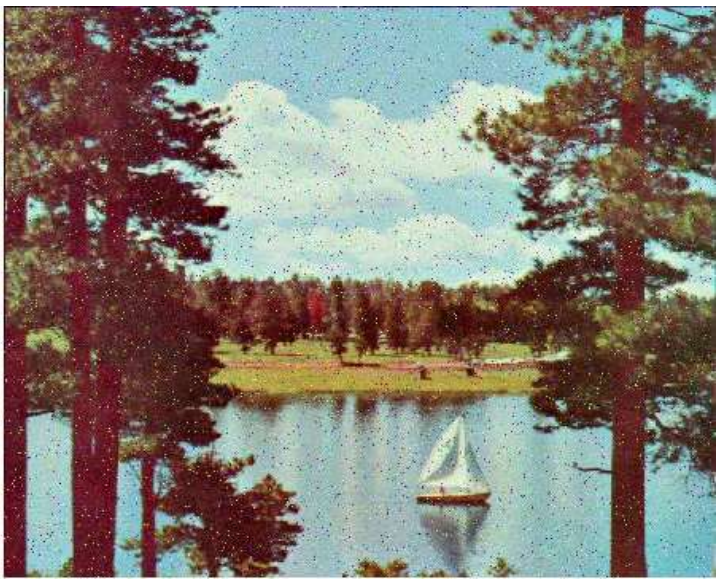


Figure 1.14: Salt & Pepper noised image

1.5.3 Speckle Noise:

This noise is baized in gestures as of basic spread, the gravity-vessel waves, and visible like a base figure. Some unusual systems are worn to reduce speckle noise which is based upon special numerical representation of the occurrence.

Figure 1.15: Speckle noised image

Speckle noise can be modelled as:

$S_N(x, y) = o(x, y)\, s(x, y) + ŋ(x, y)$

Here o(x, y) stand for the substance (means the novel picture) and $S_N(x, y)$ is the experiential image. The speckle noise strength is known like as s(x, y) and ŋ(x, y) is a Gaussian white noise.

1.5.4 Poisson Noise:

The fixed amount of elements to bring power like as electrons in an electronic path or else photons in a visual appliance is suitably minute thus to facilitate suspicions are occurring. The noise generated by this suspicions, is called poison or short noise.

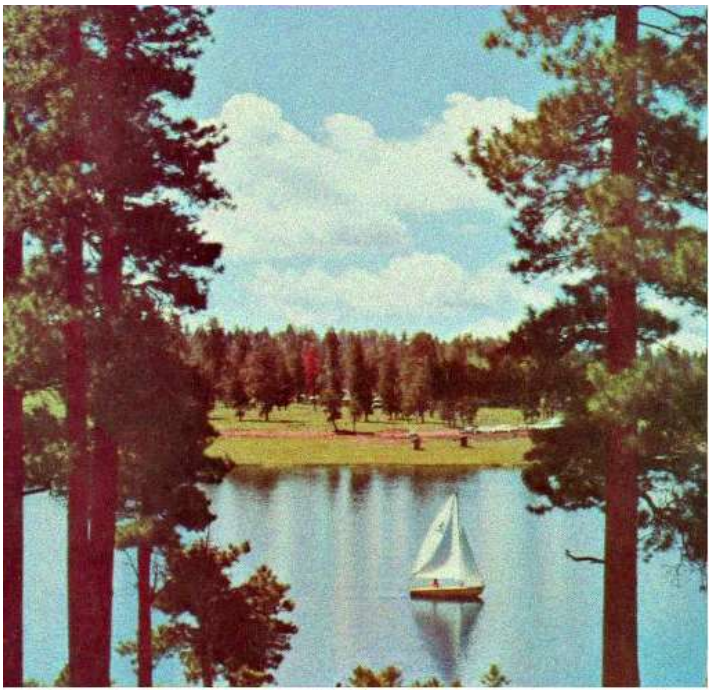


Figure 1.16: Poisson noised image

1.6 De-Noise (Filtering)

As we all know that noise is an unnecessary signal or scalar value which is not extensive; so exclusion of noise is essential. Many techniques are previously developed in past decades.

They are primarily separated into two domains [13]:

1. Spatial Domain De-noising
2. Transform Domain De-noising

1.6.1 Spatial Domain De-noising: In this method, de-noising the image is filter by the different sub-types of de-noising are following filters:

(a) Linear Filter- This Filter is based on Linear Sequential and performs the equations.

- Mean Filter
- Weiner Filter

(b) Non-Linear Filter-This Filter is also called ordered Filter which is based on the hierarchy of the mathematical representation.

- Median Filter
- Weighted Filter

1.6.2 Transform Domain De-noising: In this method, de-noising the image is filter based on transform domain and include different sub-types of filter for image de-noising.

(a) Data Adaptive Transform- In this Transform method de-noising the image by using data adaptive transform use for different noise

(b) Non-data Adaptive Transform-In this Transform method use different types of filters are based on following further more methods-

- Wavelet Domain
- Spatial Frequency Domain

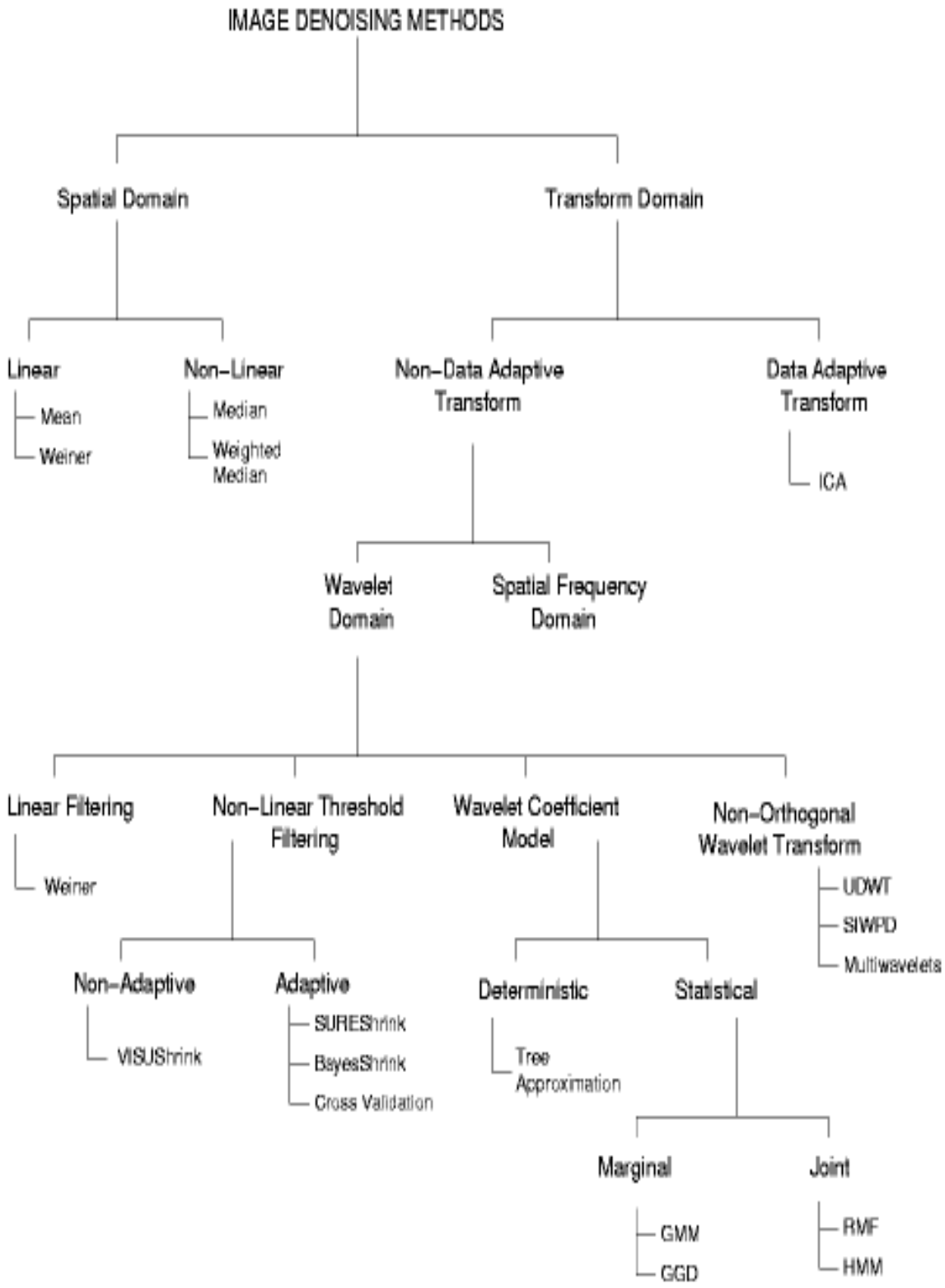


Figure 1.17: Image De-noising Methods [13].

Figure 1.17 shows the different types of methods included the filter for image de-noising. Also shows the further parts of two domains are spatial and transform domain respectively and the filtering (De-noising) the different types of noise added in images like unwanted signals. These methods show the flow of different filters in a hierarchy of the filters uses in image processing.

1.7 Problem statement

Image De-Noising (Filtering) came into existence due to the overloaded use of the images to express emotions and feeling and messages over internet. Communication media is dependable on images rather than text. Visualization gives and easiness to understand things more preciously. During the communicational transfer of data (images) over internet sometimes images get blurred or become unreadable and unrecognizable. This happens due to some extra element involvement in the original image pixels; known as noise.

This noise may be positive or negative depends on the behavior of it on original image and required to be removed. Although there are many techniques developed for the sake of de-noising. In this dissertation we will put light on Average Filter, Median Filter and Weiner Filter. These are of spatial domain filters. We have chosen DWT [14] which a transform domain element to filter out images in original image and noise.

1.8 Solution statement

DWT (Discrete Wavelet Transform) is a filter of makeover area. DWT in the past always used like a compression technique. It uses near to the ground get ahead of as well as towering leave behind strain used for the sake of density. These filters have the values which are used as a threshold for the purpose of reforming the image. Small get ahead of plus far above the ground overtake are the standards which indicate the intensity of pixels in an image.

We have utilized this property of DWT filter and designed or say modified it for the purpose of image de-noising under the name of GSL Filter. GSL Filter uses soft threshold values for image de-noising; on a window. In window the pixels are selected and maximum value is found out as threshold, and compared; which one remain high is used as threshold value.

1.9 Dissertation outline

This dissertation encounters in different part as on starting it deals with slight introduction of what I am going to do. The rest comes in the following sections:

Section II: - In this part II the technology is detailed and compared with its latest update. Many referred paper have been discussed in this chapter to analyze the need of proposed work.

Section III: - Proposed method will come over here with a detail introduction of GSL Filter.

Section IV: - Result Analysis and Conclusion.

Section V: - Future work.

Section VI: - References

Chapter 2: LITERATURE REVIEW

2.1. Literature Review:

T. Veerakumar, S.Esakkirajan, Ila Vennila,[1] In this manuscript commence a most modern algorithm for get rid of the accidental respected urge noise in metaphors and on the topic of this algorithm two period sense are strident pixels in the likeness and this pixels reinstate with the center consequence of locality clamor free of charge pixels.

The original point senses the deafening pixels in the representation and succeeding juncture, the earsplitting pixel is put back by the center worth of the district racket without charge pixels. The unchanging disparity is second-hand to make out the deafening pixel and orderly medium value precedes the piercing pixel. Algorithms of this manuscript explain superior results than the PSM, TSM, PWMAD, ODRIN and EPRIN.

Tianyi Li and Minghui Wang, Weijun Xiong [2] In this paper the algebraic possessions of the tinted clamor in wavelet area and the whitening possessions of wavelet alter, and in attendance a original process to sieve dyed sound competently. This planned process treat every characteristic associate group in wavelet sphere of influence as an average illustration with sallow clatter, and strain the clatter using the doorstep charge algorithm by iteratively nearby wavelet putrefaction. The likeness blemished by decorated clatter is then drinkable by responsibility opposite convert.

Scheme of this manuscript is autonomous of the relationship control of the painted clamor. This replication outcome spell out that the projected scheme is intelligent to get done secure or superior routine in sieve the dyed sound with lengthily concentrated working out price tag than to be had come up to, and it is also applicable to diminish white clamor.

Pawan Patidar, Manoj Gupta et.al [3]: In these document four kind of racket is used and picture de noising perform for dissimilar sound by denote sieve, middle sift and Wiener sift and wavelet convert use for de-noising a representation.

Picture giving out allocate a to a large point wider array of algorithms to be functional to the enter figures and be able to stay away from difficulty such as the augment racket and gesture deformation during meting out of metaphors. Wavelet convert have urbanized into a very commanding implement for sieve a photograph.

Wiener filter is the best suitable and accepted technique according to this paper. Gaussian clamor, Salt clatter & interrupt, disfigure clatter and Poisson clatter are used as the clatter component in this dissertation and illustration de-noising is act upon on the noised images using three filters Average, Median and Wiener filter. It is also compared for all noises in further results of this paper.

Ch.Kranthi Rekha, V.Vijaya, B.Sreedevi [4]: In the paper describes per-defined de-noising algorithms with the comparative analysis among them. Filtering approach, Wavelet based approach are the main techniques which are used in this paper for the sake of analysis. Gaussian noise, Brownian racket, brackish and infuse clatter and spoil clamor are used with noise models like additive and multiplicative.

Collection of the de-noising algorithm is function reliant. To cut the spoil clamor from the medicinal metaphors by keep hold of most of the in sequence, using fourth arrange incomplete discrepancy equations in addition to compare the consequences with next arrange partial degree of difference equation modus operandi, that is suitable for a health check practitioner or a doctor of medicine to make out well by measure up to this de-noised illustration with the get hold of.

Aim of this paper represents, the disfigure decrease appearance, the pre-dispensation footstep for segmentation, since of this subsequent to the adaptive sieve the representation know how to be used for segmentation. It is also eliminate disfigure clamor from diverse authentic point in time metaphors.

Chih-Hsing Lin, Jia-Shiuan Tsai, and Ching-Te Chiu [5]: This dissertation proposition a toggle two-pronged strain (SBF) which is a blast and consistency detector for the lay down clatter amputation manner. Two function are complete in this foremost one is recognition and the moment solitary is riddle. Sort Quadrant Median Vector (SQMV) system is wished-for for the rationale of finding element in it skin tone incorporated like perimeter or consistency in sequence.

Fancy clatter, Gaussian clatter, or clatter-at no cost is detected by means of the in sequence set aside in the SQMV by distributes the allusion medium. Best facet of SBF is this so as to lacking using an extra weighting meaning it removes together Gaussian and impulse racket. The choice in-side the two-pronged toggle amid the Gaussian and wish method depending winning the clamor result.

S. Liu [6] In this paper represent to address the difficulty of removing impulsive noise with different density from color images by this reason a new filtering algorithm is proposed which is based on noise estimation as well as adaptive scalar (SMF) and vector median filter (VMF).

According to this paper two-level noise estimation proposal is adopted for noise detection, where the first-level estimation is based on highest and smallest intensity value of each color channel, and in the second level calculation weighted directional operators are utilized. For noise reinstatement, the pure pixels are remained unaffected, and the contaminated pixels of low-to-medium thickness are restored by the twice weighted VMF, where the word double weighted means that the pixels' spatial space and extent value are biased together for the vector ordering in the calculation of vector median filtering.

H. Hua and G. de Haana,b [9] In this document, recommend a dissimilar category of nonlinear sieve, categorization-bottom mixture sieve, which together make the most of spatial, position regulate and structural in sequence in illustration handing out. This innovative strain such as concoction filters employ a vector encloses the test samples in cooperation spatial and location organize.

This future mixture strain receives a chronological grouping of in cooperation spatial and position planned learning model as the production and these coefficients are pedestal on the construction institute. During this, optimization of the expected amalgam riddle is obtained by way of the LMS algorithm.

Soumya Dutta , Bidyut B. Chaudhuri [10] This paper is represent that border uncovering is single of the nearly everyone frequently used procedure in representation giving out. Blueprint acknowledgment is in place of that the chart of an objective approximating as identify the boundaries in the representation. A periphery is the boundary stuck among a mania and the situation and point toward the boundary amid have common characteristics matter. It earnings so as to if the boundaries in a depiction can be predictable absolutely, all of the bits and pieces can be positioned and indispensable belongings such as county boundary and outline can be planned.

According to this term paper a shade representation periphery recognition algorithm is projected and arrangement of bits and pieces in an illustration. It fashioned established and

moderately good fallout. Unfailing up to standard outputs more some kind of real life metaphors include demonstrate sturdiness of the accessible scheme.

Gurmeet Kaur1, Rupinder Kaur2 [11]: In this paper, process of eliminate clamor from the innovative representation is immobile a challenging. Several algorithms proposed for this method and have its assumptions, merits, and demerits.

The primary objective of this paper is image pre-processing and then it uses the image in applications. De-noising is used as the pre processing element and this is done by the standard algorithms which are as filtering approach and wavelet based approach. Gaussian clatter, salt and pepper clamor, speckle clamor are used the most important noises used in this paper for the purpose of relative study. Best results come when the image has salt and pepper noise.

Best de-noising method which came out is wavelet based approach with noise type Gaussian. A quantitative calculation is based upon PSNR and RMSE and Correlation of the image.

Ratnakar Madan , Prof. Sunil Kr. Singh et.al [12] According to this paper, studies about the Noise and signals filtering and clamor have be a most important deterrence in indication broadcast and handing out.

In this occupation, Daubechies wavelet was second-hand to riddle out the clatter from a clumsily illustration warning sign by execute a small leave behind riddle. They be appropriate wavelet convert on the participation vector, entrance, contrary misshapen it to conclude get done an indicator with incredibly short clamor.

The encouragement for this delve into occupation was clichéd on or after the lay the blame on to increase wavelet based sieve for ECG meter filtering in addition to mark leaving out with well again results as weigh up to FIR riddle. Supplementary explanation intends was to diminish the expenditure of the equipments somewhere such nervous tension is living being used as a component.

Jian Wang1, Meng Xiangchao [13]: This document is stand on the ordinary of wavelet make over, the essential supposition of wavelet de-noising is analyzed. They proposition a vigorous wavelet convert algorithm by means of α – orderly represent riddle as is “agent” feature support on Donoho's squashy thresholding diminution approach.

Along with on this underpinning, a meticulous assessment on the understanding of two-dimensional wavelet translate is accomplished; two-dimensional in good physical shape wavelet make over algorithm is put together, and functional to depiction noise diminish. Naive indicator with clatter and sordid blunder investigation consequences make understandable that the capacities of in good physical silhouette wavelet change.

This broadsheet also uses representation question paper with brackish and interrupt clatter, compare to predictable wavelet de-noising algorithm. The results make obvious that the algorithm can professionally eradicate fancy clamor in the photograph, but it will produce the representation blurry if the coarse boo-boo doorsill is position to an only some amount bad-mannered.

Mukesh C. Motwani, Mukesh C. Gadiya et.al [14] In this paper, eradicate noise beginning the inventive warning sign is at a standstill a demanding predicament so numerous in print algorithms fashioned and every move toward has its supposition, compensation, and demerits.

Later than an epigrammatic prologue, several fashionable come within reach of are confidential into dissimilar collected works and a wide-ranging proposal of an assortment of algorithms and learning is make available. Imminent and promising expectations tendency in the neighborhood of de-noising are also converse.

Martin Vetterli [15]: This paper presents a single theory of Wavelets, sift depository, and multi promise indicator psychotherapy in the field of useful arithmetic, indication handing out, and central processing component hallucination. Firstly wavelet transform is compared with Fourier transform in the grassland of gesture handing out. It also describes the relations between filter banks, multi resolution signal processing and wavelet. It also reviews perfect reconstruction filter banks.

These filter banks are having a condition which is required to be fulfilled; known as regularity. Discrete and Continuous wavelets can be derived with these filter banks. Reconstruction of filters is done with complementary high pass filter and perfect reconstruction condition is termed as Bezout identity.

This condition is sufficient to find high level complementary filters based on an analogy with the theory of Diophantine equations. This paper also describes another approach which is based on continued fractions.

Hsin-Hui Chen [16] Wavelets, sift depository, and multi pronouncement indication examination, which encompass be used disjointedly in the countryside of matter-of-fact arithmetic, indication special consideration, and supercomputer hallucination, in that order, have just congregate to figure a introverted assumption.

In this lecture we first evaluate the wavelet change with the more traditional short-time Fourier change loom to indication analysis. Then we create the examination of the relatives between wavelets, filter banks, and multi decree signal dispensation.

We briefly reconsider great rebuilding filter banks, which can be used both for calculate the discrete wavelet foundation, afford that the filters gather a restraint known as constancy. Given a low pass filter, we take essential and enough circumstances for the survival of a balancing high pass filter that will allow perfect rebuilding.

2.2 Noise Removal Using Different Types of Filters

2.2.1 Ordered filters (non-linear)

Ordered filters are based on an exact image statistic, known as ordered statistic. They are called non-linear, because they cannot be applied as a linear operator (such as a convolution kernel). These filters work on small windows, and replace with the assessment of the central point pixel. In the well thought-out marker process the assessment of gray -level is used to sort all the pixels in sequential order. The location of an element in this ordered set can be characterized by its position.

2.2.2 Linear filters

These filters are applied by complication (a linear operation) with a low-pass filter complication kernel. In the following, the calculation of the elements of a complication kernel for Gaussian noise elimination will be obtainable.

Here we have using 3 Spatial Domain filters and later than their review we have designed a new image filter using the transform domain.

- Mean (Average) Filter
- Median Filter
- Wiener Filter

2.2.2.1 Mean Filter:

This filter is represent riddle is in addition acknowledged as normal riddle or mathematics represent pass through a strain. It operates on (M X N) image matrix with a square matrix (R X Q) descending windowpane by calculating the middling of every one of pixel standards in elevation descending porthole. Mathematics representation is as follows:

$$\text{Mean filter } (x_1 \ldots x_N) = \frac{1}{N} \sum_{i=1}^{N} x_i$$

; Here (x_1.....x_n) is image pixel range and N is no of pixels in image.

Mean Filter comes under spatial domain filter techniques in associate type liner filtering. It is fundamentally used for the removal of granule noise as its functionality gives a boom to it.

All the adjacent pixels are established to an average value which makes the image smooth but this type of filter is not good quality for finding the edge because it makes all the pixels of parallel type so becomes complicated to differentiate edges clearly.

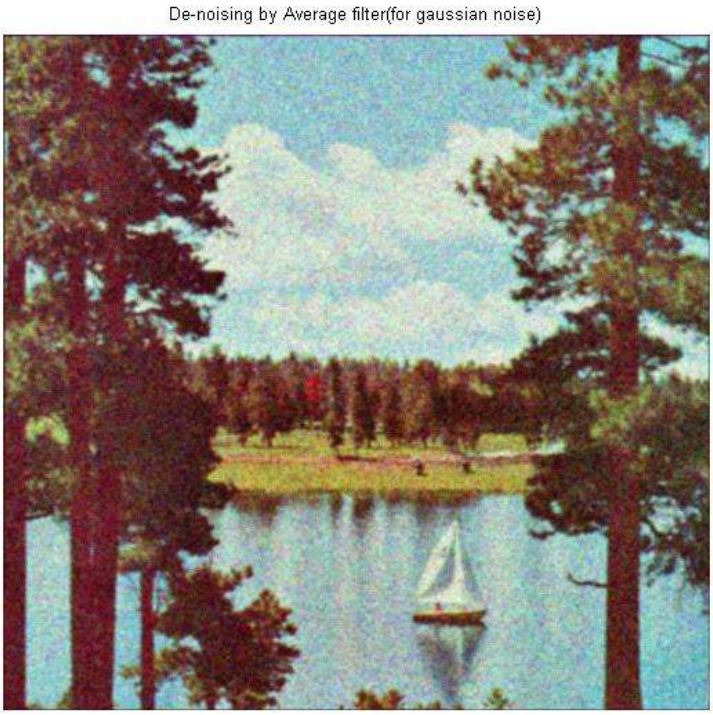


Figure 2.1: De-noising by Mean (Average) Filter

2.2.2.2 Median Filter:

Median Filter comes under the sub category Non-liner filtering of spatial domain filtering techniques. This filter also works on the similar condition on which Mean filter works.

It also uses a sliding window of (R X Q) size to procedure an image of size (M X N). Here these sizes position for the numeral of chain and paragraph engender in the prevailing conditions of the illustration as an alternative of taking the mean or average of the pixel values of the sliding window pixel it uses the median of them; to find the median first all the entries are sorted in ascending order and then (N/2 + 1) element is selected as the median value in case of odd entries in the sliding window but in the case of even number of values in the sliding window average of the elements N/2 and (N/2 + 1) is measured as the median value.

Median filter is used for the edge detection, smoothing the picture, to remove the consequence of the input noise. It is a strong filter technique used for the filtering reason of the image. The mathematical representation is as follows:

$$y(t) = \text{median}((x(t-T/2), x(t-T_1+1), \ldots, x(t), \ldots, x(t+T/2)).$$

; Here t is the dimension of the porthole along with x is the prevailing conditions. y(t) gives the median value which could be between three conditions above mentioned in the formula. Median filter is used at the same time as a pre-dispensation footstep illustration de-noising and additional riddle possibly will be entrenched with it.

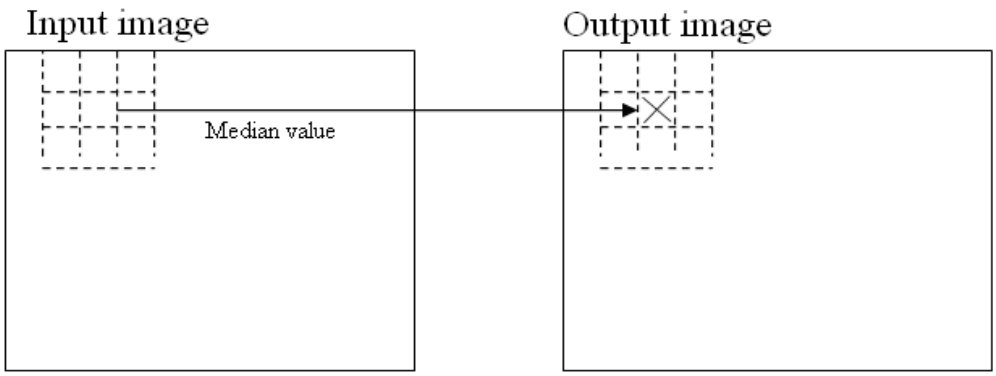


Figure 2.2: Implementation of Median Filter via a Window of size 3 X 3

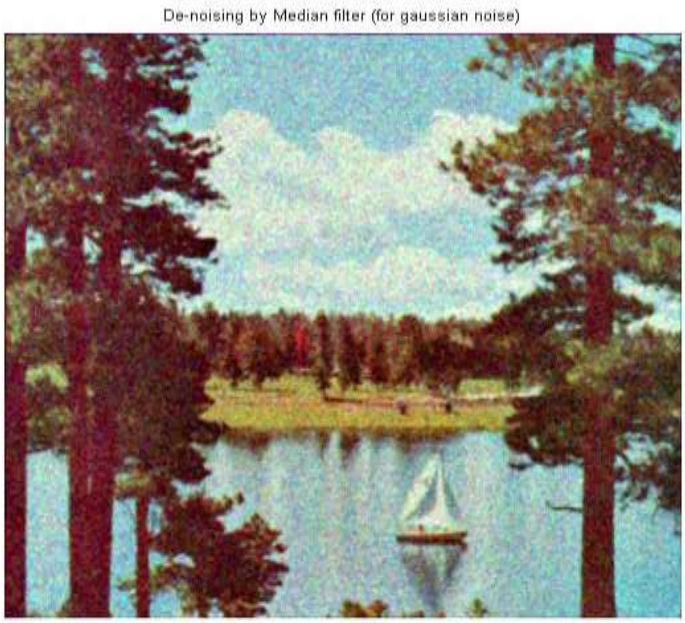


Figure 2.3: De-noising by Median Filter

Types of Median Filter:

- Maximum filter: Takes the prearranged values of pixels from the window and choose the highest value pixel from the window. The highest value is 114 as shown in the above example. This filter can be used to reduce though the pepper noise get minimized using the Maximum filter but it results in increased salt noise when used for a salt & pepper noise image.

- Minimum filter: Takes the prearranged values of pixels from the window and choose the lowest value pixel from the window. The lowest value chosen is 85 as shown in the above example. The filter minimizes the salt noise, but it shows increases in the pepper noise when used for a salt & pepper noise image.

2.2.2.3 Wiener Filter:

Wiener Filter comes under the sub group liner filtering of the spatial domain filtering techniques. It came in survival in the 1942 under the name of Mr. Norbert Wiener. It is based on statistical approach. It can work on different angles and different frequencies. It essentially removes the out noise which is surrounded in the original signal and corrupts it.

It is designed to de-noise the images using the image reinstatement solution.

These images are corrupted by a fix pattern or degradation function. The worst case noise is removed using this technique. It calculates the error in the restored image and then the error is minimized to calculate the mean error to fit to the model and restored image for de-noising.

It has three characteristics:

- ✔ Assumption that signal and the noise are stationary,
- ✔ Requirement of physically realizable filter,
- ✔ Performance high when the PSNR value becomes high.

Mathematical Representation:

$$R(u, v) = \left[\frac{1}{H(u, v)} \frac{|H(u, v)|^2}{|H(u, v)|^2 + K} \right] G(u, v)$$

; Here H (u, v) Degradation function.

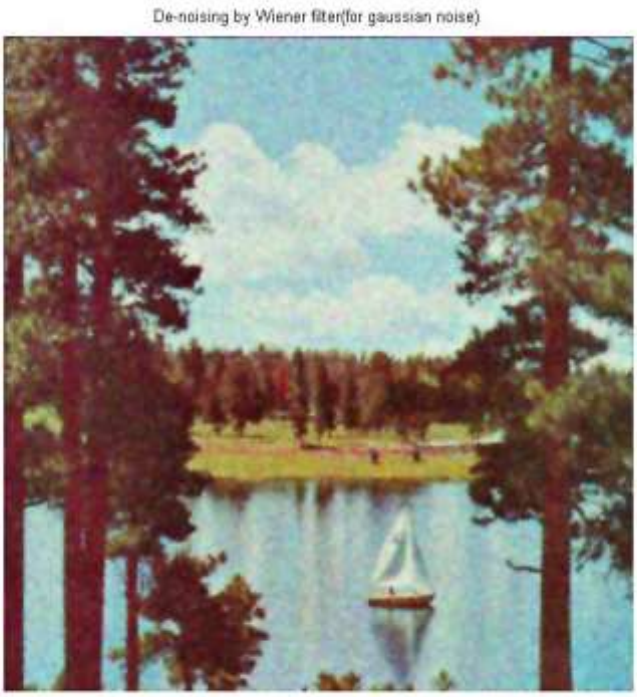


Figure 2.4: De-noising by Wiener Filter

2.3 Thresholding

1. Histogram entropy information: Entropy-foundation technique importance in algorithms, for instance, so as to employ the entropy forefront-backdrop county, the irritable-entropy sandwiched between the only one of its variety and binaries illustration etc.

2. Histogram shape information: Histogram contour-foundation performance somewhere the reaches your peak dell and curvatures of the curved histogram are evaluate.

3. Illustration attribute in sequence such as outline: Object characteristic-foundation scheme give the impression of creature for a compute of assessment sandwiched amid the gray-level and binaries metaphors, such while downy communication, silhouette, boundaries, quantity of matter etc.

4. Clustering of gray-level information: huddle-based scheme someplace the ancient echelon illustration are crowd together in two measurement as environment and center or alternately are representation as two Gaussian circulations.

5. Locally adaptive characteristics: confined scheme do not bring to a close a on its own assessment of entrance but be converted into familiarized the doorstep charge depending winning the inadequate representation individuality.

6. Spatial information: The spatial process makes use of the panorama mass occupation representation intriguing into financial credit involvement among pixels on a comprehensive weighing machine.

The notations used in the sequel are following. The h(g) and by p(g), g = 0...G, represents the histogram and the prospect collection occupation of the likeness, in that order somewhere G point toward the maximum luminance value in the image. The gray value is assumed to be between 0 to G when range is not exclusively mentioned as [gmin, gmax].

The function representing the cumulative probability is defined as $P(g) = \sum_{i=0}^{g} p(i)$.The histogram of the image is used to estimate the pmf as a result of normalizes to the numeral of illustration at each ancient altitude. In the spectacles case of handing out manuscript, the luminance standards of position of pixels a smaller amount than the entrance T forms the foreground (object), where as the locate of pixels by way of luminance standards superior than T correspond to the surroundings (object). In NDT images the dark or denser regions which are converse to the brighter area like more reflective and less dark forms the foreground part. The definition of background and foreground just simply clasp in case somewhere the purpose come into view brighter than the backdrop.

Chapter 3: PROPOSED METHODOLOGY

3.1 GSL FILTER

Although Discrete Fourier Transform was successful and implemented appropriately for image de-noising but the errors specified in it like aliasing, leakage makes somewhat problem which must be reduced. That's why we have taken Discrete Wavelet Transform and started to design a filter which actually uses the property of compression involved and tightly bounded with Discrete Wavelet Transform. The filter we proposed is termed as GSL filter under the name initials of its designers respectively "**G**arima **S**harma & Kamlesh **L**akhwani". In this filter we used the filter banks of DWT and applied the basic functionality of it which is passing the image under the filters and getting the image coefficients during the process of filtration.

3.1.1 Filter Bank:

Sift collection so as to be collection of group-overtake clean it gash the effort indication into plentiful apparatus, each get your hands on a lone occurrence subordinate-gang of the novel indication. Solitary of the submission for sieve depository is a realistic equalizer, whose is able to alleviate the machinery an additional technique furthermore recombining them into a made to order description of the innovative indication. The progression of stop working accomplish by the riddle depository is called psychoanalysis; the quantity fashioned of question manuscript that referred to as a subordinate posse indication with as numerous subordinate crowd as in attendance are sieve in the sift depository. The modernization development is entitle amalgamation, denotation reconstitution of an inclusive indication consequential from the clean progression.

In digital indication dispensation, the expression sieve depository so as to in addition in general be appropriate to a depository of earpiece. The dissimilarity is so as to recipient in addition down-exchange the subordinate posse to a dumpy midpoint happening so as to know how to be re-illustration at a solid velocity. The consequence can irregularly be talented by underneath case the posse pass subordinate band.

An additional claim of sieve depository is indication density, at what time a quantity of frequencies are nearly everybody noteworthy than others. After collapse, the vital frequencies know how to be oblique by means of a very well pronouncement. Diminutive

dissimilarity at these frequencies is significant and an arrangement method that safeguard these dissimilarity that be second-hand. On the other hand, a smaller quantity significant frequency does not contain to be truthful. A coarser regulations classification is able to be second-hand, flush although a number of the superior particulars will be nowhere to be found in the regulations.

The vectored make use of sieve depository to make your mind up amplitude in sequence of the subordinate pop group modulator warning sign and they use them to administer the amplitude of the sub pop group of a delivery service indication, therefore imposing the active uniqueness of the modulator on the delivery service.

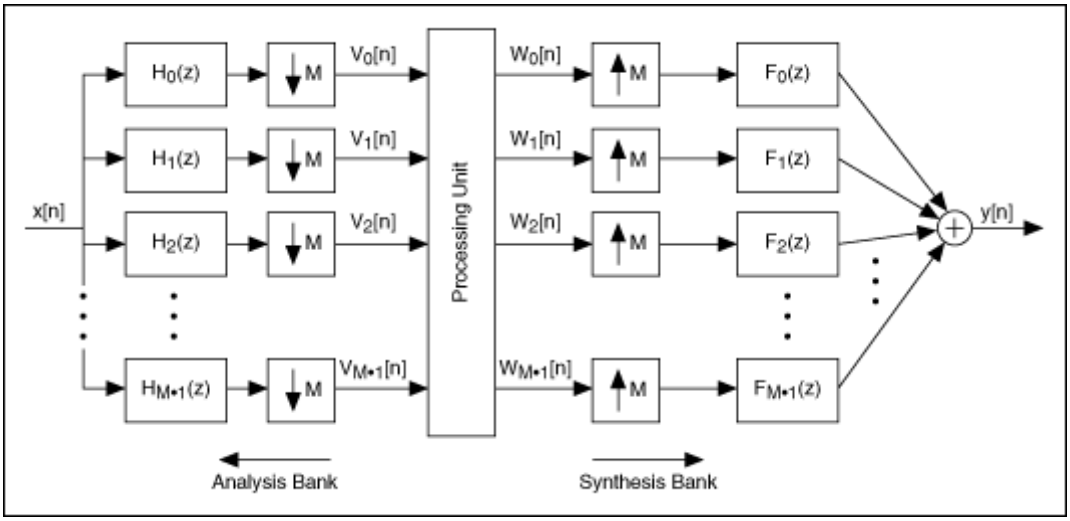


Figure3.1: DWT Filters

3.1.2 Low Pass Filter: A squat-overtake riddle is a riddle so as to pass near to the ground-incidence signals and attenuates gesture with frequencies superior than the discontinue incidence. The authentic quantities of shrinking for each one incidence are poles apart depending on explicit riddle devise. It is occasionally called a towering-engrave riddle or treble scratch pass through a filter in audio submission. A little-leave following filter is the conflicting of a far above the ground-leave in the rear riddle. A crowd-overtake riddle is a mixture of a near to the ground-overtake and a far above the ground-overtake.

squat-overtake filters stay alive in loads of dissimilar outward appearance, counting electronic circuit, opposed to-aliasing riddle for habituation signals preceding to analog-to-

digital alteration, digital strain for lustrous sets of in sequence, auditory blockade, silhouette of metaphors, and so on. The heartrending common rationale used in grassland such as sponsorship is a scrupulous nature of squat-leave behind clean, and can be scrutinize with the matching indication commerce out procedures as are tatty for additional squat-overtake riddle. Low-pass riddle proffer a smoother structure of a warning sign; eradicate the instant oscillations, and parting the longer-idiom inclination.

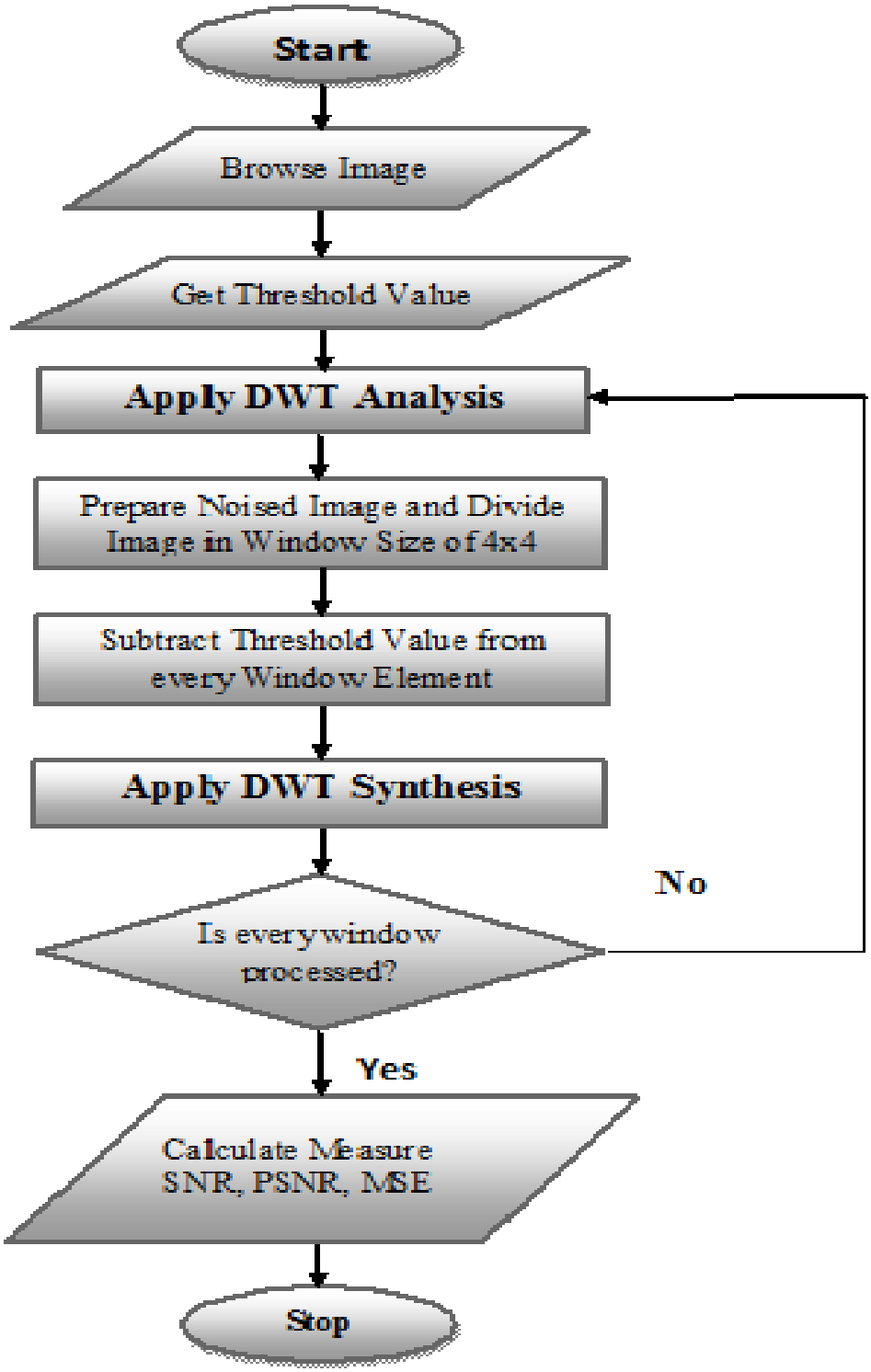
3.1.3. High Pass Filter: An elevated-overtake sift is an electronic sift so as to passes far above the ground-incidence signals but satisfies signals through frequencies inferior than the discontinue incidence. The definite quantities of reduction for every incidence show a discrepancy on or after sieve to riddle. A towering-overtake riddle is habitually reproduction while a linear moment in time-invariant classification. It is occasionally call a revealing pass through a riddle or deep-cut pass through a riddle.[1] High-pass filters enclose numerous uses, such as overcrowding DC from circuitry responsive to non-zero typical voltages or RF diplomacy. They canister also be used in coincidence with a near to the ground-outdo sift to make a crowd overtake sift.

3.1.4 Thresholding:

Filters are applied and images are compressed in previous years also, but now we have implemented thresholding with it in GSL Filter. When one a block of image in a filter process gets the coefficients of it then a threshold value is applied over the coefficients and subtracted from the intensity values which eventually smooth the image.

To make it more effective we have applied it according to a window based scheme in which the max value of intensity is calculated among a bunch of 16 elements and threshold is chosen among it or the passed value by the user and the decided is applied to window so that the luminance affects the image hardly only the chrominance values are affected which are unnoticeable and thus image get smother and de-noising took place.

3.2 Flow Chart: Represent the Flow of the de-noising method for the noised image with the respective threshold value according to the flow graph of the filter.



Flow Chart of GSL Filter Working

3.3 Algorithm:

GSL Filter (Image, Threshold)

1. Start
2. Browse Image
3. Get Soft Threshold Value
4. Add Noise to Image
5. Call Function DWT Image Filter with Noised Image and Threshold Value
6. Call Function Calculate Measures with Noised and Original Image
7. Call Function Calculate Measures with original and De-Noised Image
8. Call Function Calculate Measures with Noised and De-Noised Image
9. Prepare graph on the basis of measures generated by the above functions results
10. Stop

DWT Image Filter (Image, Threshold)

1. Start
2. Initialize pass filters
3. Apply pass filters over the image and start analyze
4. Decompose it in levels
5. Apply threshold reduction method
6. Synthesize the decomposed blocks
7. Create image in single block
8. Return image
9. Stop

Calculate Measures (Image1, Image2)

1. Start
2. Read Image
3. Find difference between the pixel interties of images
4. Calculate MSE
5. Calculate SNR
6. Calculate PSNR
7. Return MSE, SNR, PSNR
8. Stop

3.4 Code Snaps: The MATLAB code snapshots show for the different stages of the filter processing.

Code Snap1

MATLAB Code for Adding Noise in the Original Image

Matlab Code for adding Noise

```
%draw figure of original image
figure, imshow(image_read);

%find rows and columns in image
[row columns]=size(image_read);

%add noise
noised_image = imnoise(image_read,'gaussian',0.025);

%draw figure of noised image
figure, imshow(noised_image);
```

Code Snap2

MATLAB Code for the Show Different Color Components are RC, GC & BC respectively Red, Green and Blue color component

Matlab code to differentiate color components

```
% calculate the RGB components of the denoised image
 single_component_columns=columns/3;

 RC=output_signal_DWT(:,1:single_component_columns);

GC=output_signal_DWT(:,single_component_columns+1:single_component_colu
mns*2);
```

Code Snap3

```
BC=output_signal_DWT(:,(single_component_columns*2)+1:3*single_componen
t_columns);
```

Code Snap4

Implementation of the Threshold in Window processing (4x4 Matrixes)

Threshold implementation in window processing

```
for i=1:4:M
    for j=1:4:N
        z=x((i:i+3),(j:j+3));
        y1 = max(abs(z)- T, 0);
        y1 = y1./(y1+T) .* z;
        y((i:i+3),(j:j+3))=y1;
    end
end
```

Code Snap5

MATLAB code for combine the color components for resulting color image

Matlab code to combine color components

```
image_concated=uint8(cat(3,RC,GC,BC)); %merge the RGB components of the image
figure, imshow(image_concated);  %draw figure of Denoised image
```

Code Snap6

MATLAB code for the calculating the MSE, SNR and PSNR values of noised and Original image for comparative results

Matlab Code to calculate MSE, SNR and PSNR values of noised and original image

```
%calculate MSE, SNR, PSNR of original and noised image
[MSE_O_N, SNR_O_N, P_SNR_O_N]=Peak_SNR(noised_image,image_read);

% Denoising process starts using DWT
input_signal_DWT = double(noised_image);  % convert noised image to double
T = 40;    %set threshold between 0 to 128

output_signal_DWT = DWT_Filter(input_signal_DWT,T); %Denoising function
figure, imagesc(output_signal_DWT);      %draw figue of denoised image RGB components
```

Chapter 4: RESULT ANALYSIS AND CONCLUSION

4.1Result Analysis

GSL Filter is implemented in MATLAB using the DWT transformation for image de-noising and in this paper we have provided other paper which already worked on image de-noising using the spatial domain filters. Although they are sufficient for the sake of image de-noising up to a mark but now it time to raise the power of image processing and give the best result which gives drastic changes to the image level communication. To support the statement GSL Filter is processed using the transform domain in which actually substitution not take place but partially shows its existence under the name of soft thresholding. We have applied GSL Filter on a image with different types noises. First a image is taken and noise are added to it and the applied the GSL filter on them and measurements are noted down and analysis is done on the basis of them. Basically PSNR value played an important role in the analysis which is a mathematical representation of image quality and propositional to the quality of image. As much the PSNR comes the image would be low noise and good quality. Formulas are mentioned below:

$$\mathrm{SNR} = 10 \cdot \log_{10} \left[\frac{\sum_{0}^{n_x-1} \sum_{0}^{n_y-1} [r(x,y)]^2}{\sum_{0}^{n_x-1} \sum_{0}^{n_y-1} [r(x,y) - t(x,y)]^2} \right] \quad \ldots (4.1)$$

$$\mathrm{MSE} = \sqrt{\frac{1}{n_x n_y} \cdot \sum_{0}^{n_x-1} \sum_{0}^{n_y-1} [r(x,y) - t(x,y)]^2} \quad \ldots (4.2)$$

$$\mathrm{PSNR} = 10 \cdot \log_{10} \left[\frac{\max(r(x,y))^2}{\frac{1}{n_x \cdot n_y} \cdot \sum_{0}^{n_x-1} \sum_{0}^{n_y-1} [r(x,y) - t(x,y)]^2} \right] \quad \ldots (4.3)$$

4.4.1 De-noised Images:

Figures with different noise are below and their de-noised images (by GSL Filter) are with them respectively.

Figure 4.1: Original Picture

Figure 4.2:Noised Picture: Gaussian

Figure 4.3: De-noised Picture: Gaussian

Figure 4.4:Noised Picture: Poisson

Figure 4.5: De-noised Picture: Poisson

Figure 4.6:Noised Picture: Speckle

Figure 4.7: De-noised Picture: Speckle

Figure 4.8: Noised Picture: Salt & Pepper

Figure 4.9:De-noised Picture: Salt & Pepper

4.1.2 Comparative Images

In this comparative state the resulting images (lake, Lena and house image) are used. Figures with Original image, Gaussian noise image are below and their de-noised images. De-noised by the Average, Median, Weiner and GSL Filter.

Figure : 4.10: Original Picture

Figure 4.11:Noised Picture: Gaussian

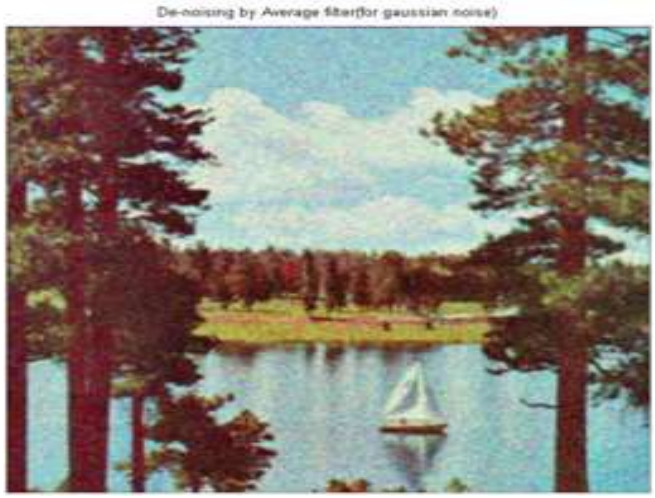


Figure 4.12: De-noising by Mean(Average) Filter

Figure 4.13 : De-noising by Median Filter

Figure 4.14 : De-noising by Weiner Filter

Figure 4.15 : De-noising by GSL Filter

Values are calculated using the formulas and graph is plotted according the values which imply that the GSL Filter is best ever filtering used for image De-Noising.

	SNR (dB)	**MSE**	**PSNR (dB)**
Noisy Image	7.6408	651.7114	19.7834
Average Filter	9.2304	283.0615	23.5779
Median Filter	8.6185	375.5525	22.3841
Weiner Filter	9.6179	236.8026	24.0039
GSL Filter	10.0198	210.9158	24.6829

Table 4.1: Comparison SNR, MSE & PSNR Values for Lake Image

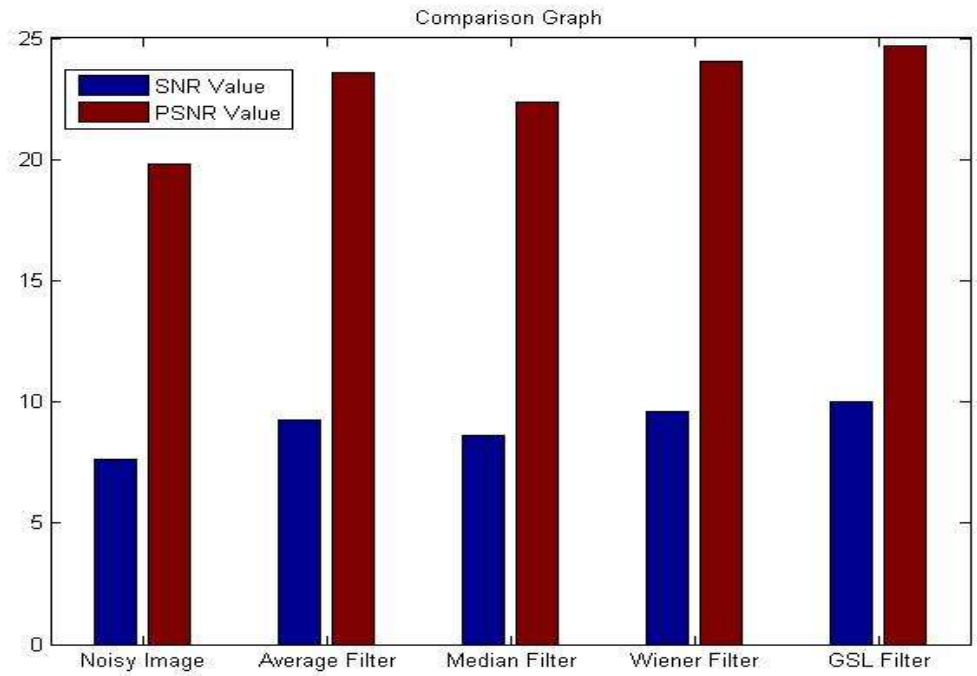


Figure 4.16: Graph PSNR Value Comparison (Lake Image)

Figure 4.17: Original Picture

Figure 4.18: Noised Picture: Gaussian

Figure 4.19: De-noising by Mean(Average) Filter

Figure 4.20 : De-noising by Median Filter

Figure 4.21: De-noising by Weiner Filter

Figure 4.22: De-noising by GSL Filter

	SNR (dB)	MSE	PSNR (dB)
Noisy Image	7.8708	661.2846	19.6148
Average Filter	9.5812	272.5516	23.6390
Median Filter	9.1575	331.2730	22.9289
Weiner Filter	10.3639	190.0615	24.9232
GSL Filter	10.8652	162.1115	25.7206

Table 4.2: Comparison SNR, MSE & PSNR Values for House Image

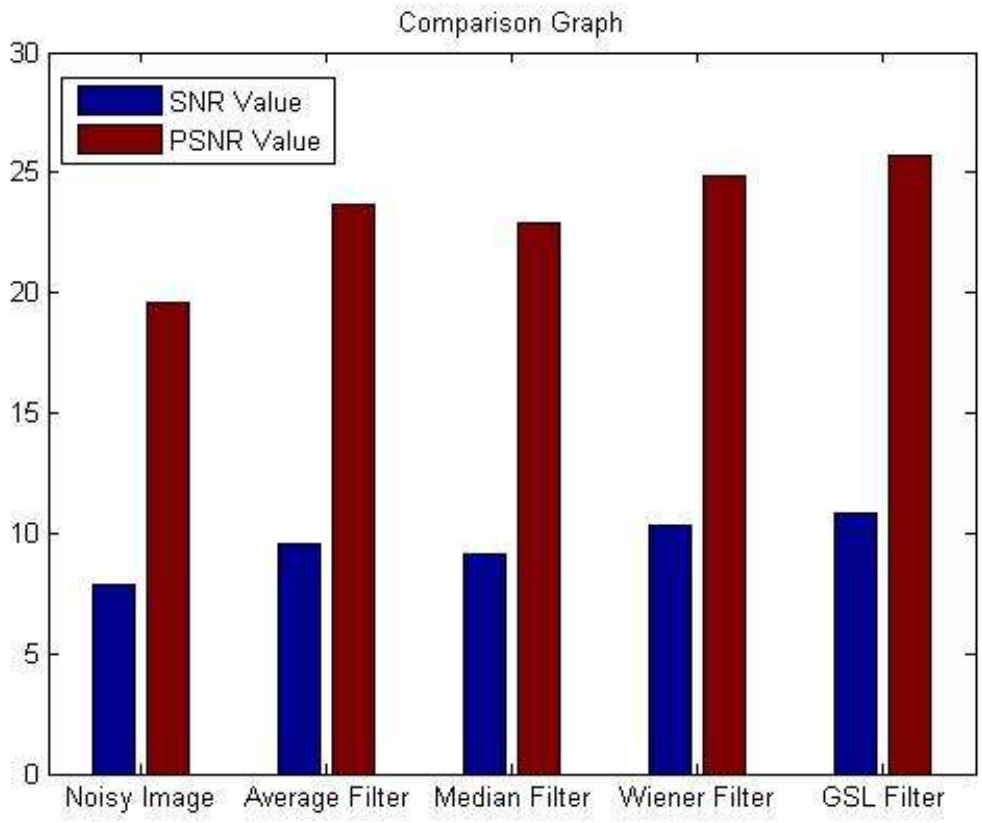


Figure 4.23 Graph PSNR Value Comparisons for (House Image)

Figure 4.24: Original Picture

Figure 4.25: Noised Picture: Gaussian

Figure 4.26: De-noising by Mean(Average) Filter

Figure 4.27 : De-noising by Median Filter

Figure 4.28: De-noising by Weiner Filter

Figure 4.29: De-noising by GSL Filter

	SNR (dB)	MSE	PSNR (dB)
Noisy Image	7.6289	652.1146	19.9876
Average Filter	9.4002	260.6743	23.9698
Median Filter	8.8290	339.1135	22.8274
Weiner Filter	9.8967	207.3964	24.7210
GSL Filter	10.4375	173.5262	25.7372

Table 4.3: Comparison SNR, MSE & PSNR Values for Lena Image

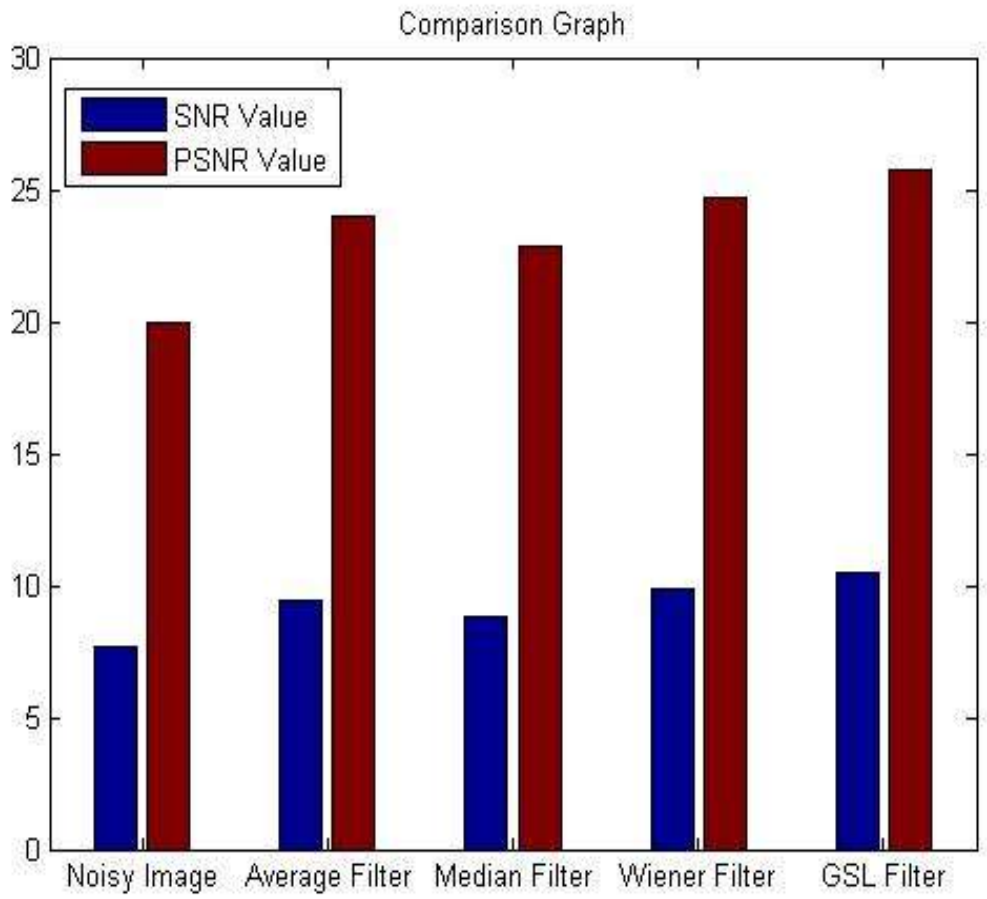


Figure 4.30 Graph PSNR Value Comparisons for (Lena Image)

4.2 Conclusion

In this research work we have studied three spatial domain filters and designed a new filter of transform domain named as GSL filter after the name initials of its founder “Garima Sharma” and “Kamlesh Lakhwani”. GSL filter works on the basis of DWT transform compression property and pass filtering concepts. This research works gives a comparative study between all these filters. The comparative study make the statement clearly that GSL Filter have best result in both comparison as PSNR value comparison or image viewing. GSL filter is applicable on each type of digital image format whether it is gray-scale or color image. We have used Lake Image in tiff format with RGB color mode and applied DWT based GSL Filter to remove noise from it which was done successfully and results were better after comparison from other filters used in past and hope it will definitely work in future until someone else wont cross the limits of research and won’t try to do some special efforts to beat GSL filter.

Chapter 5: FUTURE WORK

Future Work

Transform Domain techniques are fairly used in compression of signals, images in past, we proposed a way to make an advantage over it, we gave moved a step further by using DWT as filter for image de-noising.

In future we will propose this algorithm to work on videos using the frame separation and decomposition of the separated image using DWT.

References

[1] T. Veerakumar, S. Esakkirajan , Ila Vennila "An Efficient Approach to Remove RandomValued Impulse Noise in Images" ISBN: 978-1-4673-1601-9/12/$31.00 ©2012 IEEE.

[2] Li, Tianyi "A Novel Method for Filtering of Gaussian Colored Noise In Images with Wavelet Transform" International Conference on Electronics and Information Engineering (ICEIE 2010).

[3] Pawan Patidar, Manoj Gupta, Sumit Srivastava, Ashok Kumar Nagawat "Image De noising by Various Filters for Different Noise" International Journal of Computer Applications (0975 – 8887) Volume 9– No.4, November 2010.

[4] Ch.Kranthi Rekha, V.Vijaya, B.Sreedevi, "Comparison of Higher Order Diffusion Filters for Speckle Noise Reduction" International Conference on Computer Applications and Industrial Electronics (ICCAIE 2010).

[5] Lin, Chih-Hsing "Switching Bilateral Filter with a Texture/Noise Detector for Universal Noise Removal".

[6]S. Liu "Adaptive scalar and vector median filtering of noisy color images based on noise estimation" Published in IET Image Processing ISSN 1751-9659, 2010.

[7] Image file format, "Scantips", http://www.scantips.com/basics09.html

[8] OGE MARQUES "Practical Image And Video Processing Using Matlab®"

[9] H. Hua and G. de Haana,b "Classification-based Hybrid Filters for Image Processing-paper".

[10] Soumya Dutta, Bidyut B. Chaudhuri "A Color Edge Detection Algorithm in RGB Color Space" International Conference on Advances in Recent Technologies in Communication and Computing © 2009 IEEE

[11] Gurmeet Kaur, Rupinder Kaur, "Image De-Noising Using Wavelet Transform and Various Filters" International Journal of Research in Computer Science ISSN 2249-8265 Volume 2 Issue 2 (2012).

[12] Ratnakar Madan, Prof. Sunil Kr. Singh "Signal Filtering Using Discrete Wavelet Transform" International Journal of Recent Trends in Engineering, Vol 2, No. 3, November 2009

[13] Mukesh C. Motwani, Mukesh C. Gadiya, Rakhi C. Motwani, Frederick C. Harris "Survey of Image Denoising Techniques"

[14] Martin Vetterli "Wavelet and filter bank-paper" IEEE Transactions on Signal Processing, Vol. 40, No.9, September 1992.

[15] Hsin-Hui Chen “Wavelet_Filter”

[16] R. Gonzalez, R. Woods WW, “Digital Image Processing 2nd ed”

[17] D. L. Donoho, “De-noising by soft-thresholding”, IEEE Trans. Information Theory, vol.41, no.3, pp.613-627, May1995.

[18] David L. Donoho and Iain M. Johnstone,“Ideal spatial adaption via wavelet shrinkage”, Biometrika, vol.81, pp 425-455, September 1994.

[19] M. K. Mihcak, I. Kozintsev, K. Ramchandran, and P. Moulin, "Low-Complexity Image Denoising Based on Statistical Modeling of Wavelet Coefficients," IEEE Signal Processing Lett. (to appear).

[20] Alexander D. Poularikas, “Transforms and Applications Handbook”, 3rd ed., New York, CRC Press, 1996.

[21] C. Gasquet and P. Witomski, “Chap. XII”, Analyse de Fourier et Applications, Masson, Paris 1990.

[22] Y. Sheng, D. Roberge, and H. Szu, “Optical wavelet transform”, Optical Engineering, Vol. 31 Issue 9, 1992, pp 1840–1845.

[23] H. Szu, Y. Sheng, and J. Chen, “The wavelet transform as a bank of matched filters”, Applied Optics, Vol. 31 Issue 17, 1992, pp 3267–3277.

[24] M. O. Freeman, “Wavelet signal representations with important advantages”, Optics & Photonics News, Vol. 4 Issue 8, August 1995, pp 8–14.

[25] I. Daubechies, “The wavelet transform: Time-frequency localization and signal analysis”, IEEE Transactions on Information Theory, Vol. 36, 1990, 961–1005.

[26] S. Mallat, “A theory for multiresolution signal decomposition: The wavelet representation”, IEEE Transactions on Pattern Anlysis and Machine Intelligence PAMI-31, Vol. 11 Issue 7, 1989, pp 674–693.

[27] T. Hopper, “Compression of gray-scale fingerprint images”, Proceedings of SPIE 2242, 1994, pp 180–187.

[28]Bryan s. Morse, “Thresholding” Brigham Young University 1998-2000.

[29] Amit Pande , Joseph Zambreno “Design and Analysis of Efficient Reconfigurable

Wavelet Filters”

[30] Kurt OSTERLOH 1, Uwe ZSCHERPEL 1 “Ways of Digital Image Processing to Obtain Fast and Unbiased Results” 18th World Conference on Nondestructive Testing, 16-20 April 2012, Durban, South Africas

[31] Jian Wang1, Meng Xiangchao “Study on Robust Noise Reduction Algorithm Based on wavelet transform" ©2011 IEEE