INTDRODUCTION

The image enhancement is a technique or in other words process of adjusting the digital images and the resultant image which we get are more suitable for display. Improving how well humans and other automated image processing techniques perceive the information in an image is the goal of image enhancement. It is a technique for applying an operation to an image to obtain an improved image and extract certain data from it. An image is the input in this image processing method, and the output could be any unique qualities connected to that specific image. For this, MATLAB is an extremely useful tool. Developed by Math Works, MATLAB is a high-performance programming language in an intuitive environment. The primary benefit of MATLAB is its extremely high numerical precision. Different techniques will be employed pixel by pixel to accomplish a multitude of tasks, such as converting a picture to black and white, binary, negative, or higher brightness, edge detection, reducing noise from salt and pepper, and so on.

A picture is meant to inform visitors who are not humans. When processing numerical data, computers process it more quickly and accurately than humans. However, when it comes to identification ability, humans outperform computers. All five senses are used by humans to acquire information about their environment. The well-known Chinese saying "A picture speaks a thousand words" accurately highlights the fact that pictures can convey information to viewers in a variety of contexts, including text for readers, forensic photos for police investigations, and medical images for doctors, among others. Clarity of the images is impacted during the acquisition process by factors including illumination, weather, distance, or the equipment utilized to take the images. Enhancement essentially raises the quality of the visuals by making the images visible to the human eye and/or to machines via automated processing methods.

Some of the tool basic tools used in MATLAB for image enhancement are:

- imread - to read an image
- imshow-to display the original image
- imadjust-to adjust brightness and contrast
- histeq-for histogram equalization

The method we present in this paper incorporates the notion of image processing for both image enhancement and picture reduction according to our application. The suggested work explains how to use Matlab to access each image's component parts. To carry out different duties, different enhancement techniques will be performed pixel by pixel.

Literature Review

The history of digital image processing and computer development are intertwined. It is vital to use computers and technology that can handle the massive storage and processing demands of digital photographs.

Parallel to the growth of space applications in the 1960s and 1970s, digital image processing techniques started to be developed in a variety of disciplines, including astronomy, biology, medicine, and geology. Thanks to recent technological advancements, digital image processing is now a routine task that is necessary for solving problems in a variety of applications and devices. To obtain the best solutions, the user only needs to comprehend the issue and know how to use the tools that are currently on the market [1].

All types of information are going through a digitalization process in the modern day. Naturally, the pictures were unable to evade this procedure. Thousands of digital images are created by photography, cinema, television, graphic design, and even industrial design. These images can be printed on paper, exhibited on a screen, transferred electronically, or saved on a physical medium.[2]

Digital image processing is the process of reducing the size or improving the quality of digital images in order to prepare them for transmission or storage. The collection of methods used on digital photographs to enhance their quality or make information searches easier is known as digital image processing.[3].

Objectives

- To improve the visual quality of images for human interpretation.
- To improve image brightness while suppressing image noise.
- To transform an image into digital form and perform certain operation.
- To improve the sharpness of the image by enhancing high-frequency components.
- To enhance the distribution of pixel intensities in the image.
- To improve the distinguishability between different objects or regions in the image

Work carried out

- **METHODS OF IMAGE ENHANCEMENT**
- Morphological operators.
- Wiener filter
- Contrast limited adaptive histogram equalization (CLAHE)
- Decorrelation stretch

1.MORPHOLOGICAL OPERATOR

Morphology is a of operations that process images based on shape. morphological operators are used to examine and work with an image's object structure. For applications like form analysis, noise reduction, and edge recognition, these operators are especially helpful. Morphological operations on images can be carried out using a set of functions offered by MATLAB. In this method each pixels in the image is adjusted based on the value of other pixel in it's neighboured.

- Few morphological operators used in MATLAB are:
- imopen-to open the image
- imclose-to close the image
- strel-to create a structuring element
- rgb2grey-to convert a color image (in RGB format) to grayscale

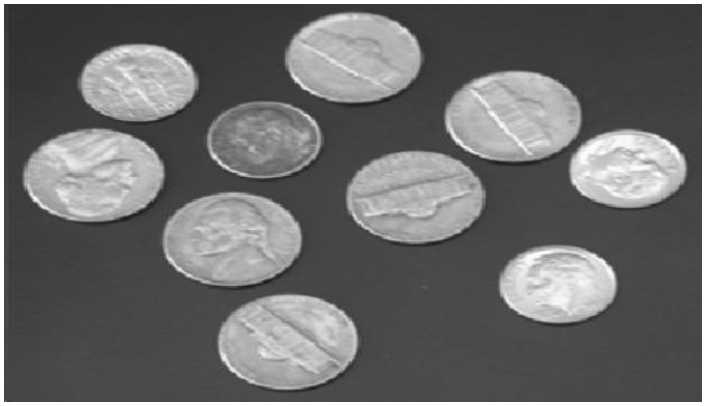

Fig 1. Sample image taken to study

EXAMPLE PROGRAM

```
//to study the morphological characteristics of a particular image

I = imread('coins.png');
imshow(I);  % Make unifom background
Se = strel('disk',35);%flat structure element
background = imopen(I,Se);
I2 = I- background;
imshow(I2)
% to contrast image
I4  =  im2gray(I2);
I3  =  imadjust(I4);
imshow(I3);
% To convert into binary version
bw = imbinarize(I3);
bw = bwareaopen(bw ,50);
% To identify number of objects
cc      =      bwconncomp(bw,4)
cc.NumObjects
coin      =      false(size(bw));
coin(cc.PixelIdxList{5}) = true;
imshow(coin)
coin_data = regionprops(cc,'basic');
coin_areas    =    [coin_data.Area]
coin_areas(5)
```

Fig 2. I2

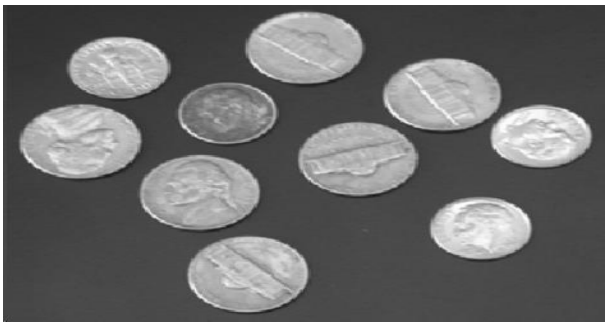

Fig3. I3

Fig 4. 5th coin

```
ans =

    13

>>
```

Fig 4. Number of coins

```
ans =

        2746

>>
```

Fig 5. Area of 5th coin

2. WINER FILTER

Winer filter is used to de-blur the images. Norbert Wiener proposed the Wiener filter inthe 1940s, and it was published in 1949.By comparing a signal's actual signal to an estimate of the ideal noiseless signal, it seeks to minimize the noise in the signal. Since the Wiener filter's theory is predicated on the assumption that the inputs are stationary, it is not an adaptive filter[4].

Removing noise that has tainted a signal is the aim of the Wiener filter. It is predicated on statistical analysis. Typical filters have a specific frequency response in mind.[5]. This filter is commonly employed during the deconvolution process. For images deteriorated by additive noise and blurring, the Wiener filter is therefore the best stationary linear filter based on Minimum Square Error (MSE).

Few Algorithms used in Weiner filter

- fspecial- To create predefined filters for image processing.
- im2double – To convert an image from its original data type(such as unit 8 or unit16) double precision
- imfilter – Used for filtering images.
- deconvwnr – Used for deconvolution with Weiner filtering.
- Conv – Used for performing convolution operations between two vectors or sequence.

EXAMPLE PROGRAM

```
%To creat blured image
Ioriginal = imread("flower.jpeg");
figure(1);
imshow(Ioriginal);
PSF = fspecial('motion',21,11);%21-length,11-angle
Idouble = im2double(Ioriginal);
blurred = imfilter(Idouble,PSF,'conv','circular');
figure(2);
imshow(blurred);
wnr = deconvwnr(blurred,PSF);
figure(3);
imshow(wnr)
```

Fig 6. Blurred image

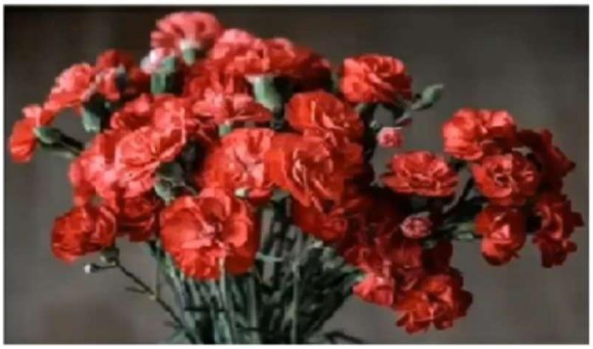

Fig 7. Filtred image

3.Contrast limited adaptive histogram equalization (CLAHE)

A method for processing photos that increases contrast by locally adjusting the pixel intensity histogram is called Contrast Limited Adaptive Histogram Equalization, or CLAHE. It works especially well at getting around the drawbacks of conventional histogram equalization, which has a propensity to increase noise and can result in over-enhancement in some areas of an image.

Computer image processing technic is used to improve contrast in the images, unlike histogram equalization, Adaptive method computes several histograms each corresponding to the distinct section of the image, Adaptive histogram equalization have more tendency to overamplify noise in relatively homogenous regions of an image. To overcome this drawback, CLAHE is used.

- Few Algorithms used in CLAHE

- adapthisteq - enhances the contrast of an image by redistributing the intensities in the image histogram.
- lab2rgb - to convert an image from the CIELAB color space to the RGB color space.

- montage - to display multiple images in a single figure window, arranging them in a montage style.
- imshowpair - to display and compare two images side by side.

EXAMPLE PROGRAM

```
I = imread("moon.jpeg");
figure(1);
 imshow(I);
 LAB = rgb2lab(I);
 L = LAB(:,:,1)/100;
 L = adapthisteq(L,"NumTiles",[8,8],"ClipLimit",0.005);
 LAB(:,:,1) = L*100;
 J = lab2rgb(LAB);
 figure(2)
imshowpair(I,J,'montage')
title('original(left) and contrast enhanced image(right)');
```

Fig 8. Sample image taken for enhancement

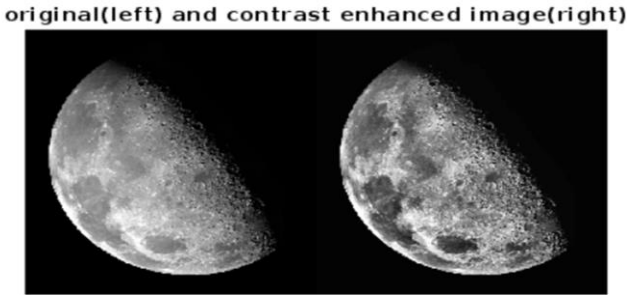

Fig 9. resultant image

4.Decorrelation stretch

A method for enhancing (stretching) the color differences present in a color image is called decorrelation stretch. The phrase "decorrelation stretch" refers to the technique employed to do this, which involves eliminating the inter-channel correlation present in the input pixels.[6] Decorrelation stretch is a technique used in remote sensing and image processing to enhance the visual interpretation of satellite or aerial imagery. By altering the data in a way that decorrelated the spectral information, decorrelation stretch seeks to improve color contrast in an image and produce a more aesthetically pleasing and informative representation.

The primary objectives and advantages of MATLAB's Decorrelation Stretch:

- To Enhancement of Color Contrast
- To Improved Discrimination of Features
- To Reduced Atmospheric Effects
- To Increased Image Interpretability
- Few Algorithms used in CLAHE
- decorrstretch - for contrast stretching and decorrelation of color images.
- Imadjust - to enhance the dynamic range of the image.
- lab2rgb - to convert an image from the CIELAB color space to the RGB color space.

EXAMPLE PROGRAM

```
I = imread("bird.jpeg");
figure(1);
imshow(I);
S = decorrstretch(I,'tol',0.01);
figure;
imshowpair(I,S,'montage')
title('original(left) and color seperation enhanced image(right)');
```

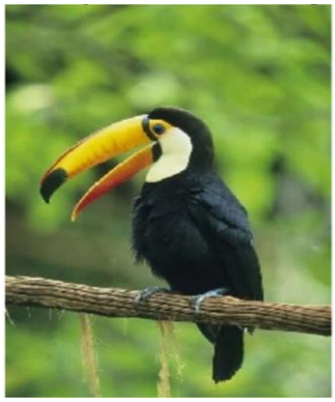

Fig 10. Sample image taken for decorrelation stretch

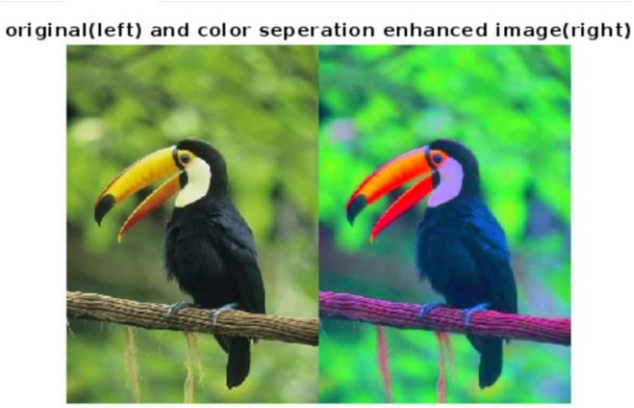

Fig11.Result image

Methods	Enhanced specification
Weiner Filter	Every blurred image has it's own limit to clear the blur . This method will clear the given image up to it's maximum limit
CLAHE	In the above given example, we increased the colour contrast by 0.005 precision.
Decorrelation stretch	In the above given example, we stretched the image to increase the colour separation by 0.001 precision.

Conclusions

I have gained the confidence and understanding to dig more thoroughly into the qualities of knowledge and the process of its evolution because of this effort. As a result, I figured out the potential for the practical application of computer for the creation and development of new knowledge engineering concepts

The study of image enhancement in MATLAB has provided valuable insights into various techniques and methodologies aimed at improving the visual quality and interpretability of digital images. The study not only provided a comprehensive understanding of image enhancement techniques in MATLAB but also highlighted the need for a nuanced and application-specific approach. The knowledge gained lays the foundation for informed decision-making in choosing and implementing image enhancement methods based on the unique requirements of diverse imaging applications. Future work may involve further exploration of advanced techniques and the integration of machine learning approaches for adaptive enhancement in dynamic environments.

REFERENCES

- [1]. FITER, E. L. Descripción, comparación y ejemplos de uso de las funciones de la Toolbox de procesasdo digital de imagenes en Matlab. Universidad Politécnica de Madrid. Madrid. 2012
- [2]. KHOSROW-POUR, M. The Encyclopedia of Information Science and Technology. third. ed. [S.l.]: [s.n.], 2014.
- [3]. Ms. I. Suneetha and Dr. T. Venkateswarlu. 2012. Enhancement Techniques for Gray scale Images in Spatial Domain. International Journal of Emerging Technology and Advanced Engineering, website: www.ijetae.com (ISSN 2250-2459). 2(4): 13-20.
- [4]. Introduction of wiener filter, www. en.wikipedia.org/wiki/Wiener_filter 6th Nov. 2012
- [5]. Brown, R. Grover; Hwang, Patrick Y.C. " Introduction to Random Signals and Applied Kalman Filtering "(3 ed.). New York: John Wiley & Sons. ISBN 0-471-12839-2 (1996).[5]