ABSTRACT

Today's digital photography process, medical process, x-rays etc. are used in image zooming as a main task. It is the method of amplifying the image to any factor of magnification only in appearance. Whereas an image zoomed, there are little parameters that we have to keep in mind. Because the Zoomed image or Resultant image creates some artifacts like that , image blur, edge distortion, blocking effects noise, etc., so Zoomed image is not exactly same as Original image because of these artifacts. So in this thesis, we will focus mainly on the reduction of these artifacts.

In this thesis we use a proposed interpolation algorithm for image zooming. A process in which we expand an image by a factor (greater than one) i.e. magnification factor is called image zooming. So, when we apply zooming function generally to an image, it will usually effect in aliasing; edge blurring and other artifacts. In our proposed method, the adaptive bilinear interpolation method is working to expand the original image. We are using the pixel grouping procedure to execute and to classify the pixels in the enlarged image. According to experimental resultant data, it is displayed that our proposed system provides better image quality. We can evaluate the result in terms of visual appearance and also in terms of PSNR.

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1 What is Digital Image?

A **Digital Image** is represented with the help of binary number like ‘0’ or ‘1’ values in two dimensions. Digital Image normally referred as Raster image. Raster image states that an image contains of finite set of digital values and these digital values are called pixel or we can say that picture elements. In any digital Image the smallest element is pixel that holds quantum value and helps to represent the brightness of particular color. We can represent a digital image by $a[m, n]$ where M represents columns and N represents rows. We can derive a digital image from an analog images $a(x, y)$ in a 2D continuous space by a method that is called a *sampling* process and also referred as digitization. The action of digitization is shown in Figure 1.1

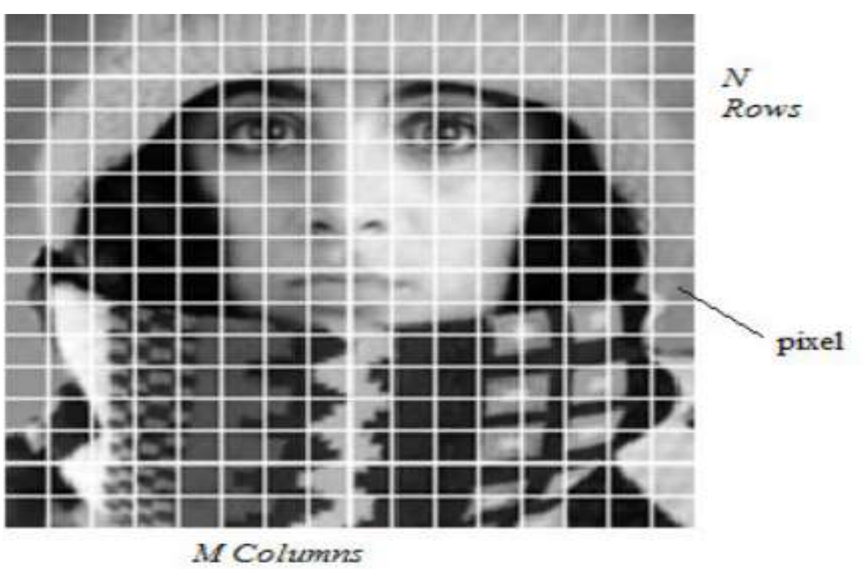


Figure 1.1:- digitization of continuous image

a (x, y) is a 2D continuous image and divided into N rows and M columns. The intersection of a row and a column is denoted as a pixel. The value allotted to the integer coordinates [m, n] with {m=0,1,2,…,M–1} and {n=0,1,2,…,N–1} is a[m, n].[1]

1.1.1 DIFFERENT TYPES OF DIGITAL IMAGE ARE AS:-

a.TIFF: TIFF also named as Tagged Image File Format. TIFF is used to interchange files among applications and computer platforms. TIFF is generally supported by almost all paint, image editing, and page-layout application

b. PICT: PICT also stands for 'Picture' and it is able to store 8-bit, 16-bit or 24-bit color or gray scale images. PICT files also work for the on screen presentation of graphics.

c. JPEG: JPEG stands for "Joint Photographic Experts Group". JPEG is truly a standard way of squeezing graphics by eliminating luxury information. A JPEG file is created from maximum file formats and commonly used for web-based images because small file size is essential.

d.GIF: GIF also stands for 'Graphic Interchange Format', and it is used for modest web images. The limitation of GIF files are up to 256 colors, it is recommended for not to use this format for images, photographs or other pictures with high color ranges.

e. PNG: PNG stands for "Portable Network Graphics" format. PNG is an open source supernumerary for GIFs. PNGs also deliver an advanced lossless compression rate than GIFs, and also help to decrease cross-platform variances in image display quality, among other technical advantages.

If we want to share files, add images to Power Point presentations and then to post them to websites, the formats we like most to use are JPG and GIF. Because these files are nearly universally understandable by image editors, work well on websites, and offer small file sizes with reasonable quality levels.

1.2 What is Digital Image Processing?

When we manipulate an image by means of a processor then that is called **Digital Image Processing** of that image. It is a technique to convert a continuous image into digital form and then it perform some operation like enhancement the image, Image compression, Image restoration. Simply we can say that the field of Image processing refers to the processing of images or it is also defined as a method to convert an image into digital form to extract some useful information from it. In Image processing we treat image as two dimensional signals. The greatest common uses of Digital image processing techniques are improving picture quality and remove noise.

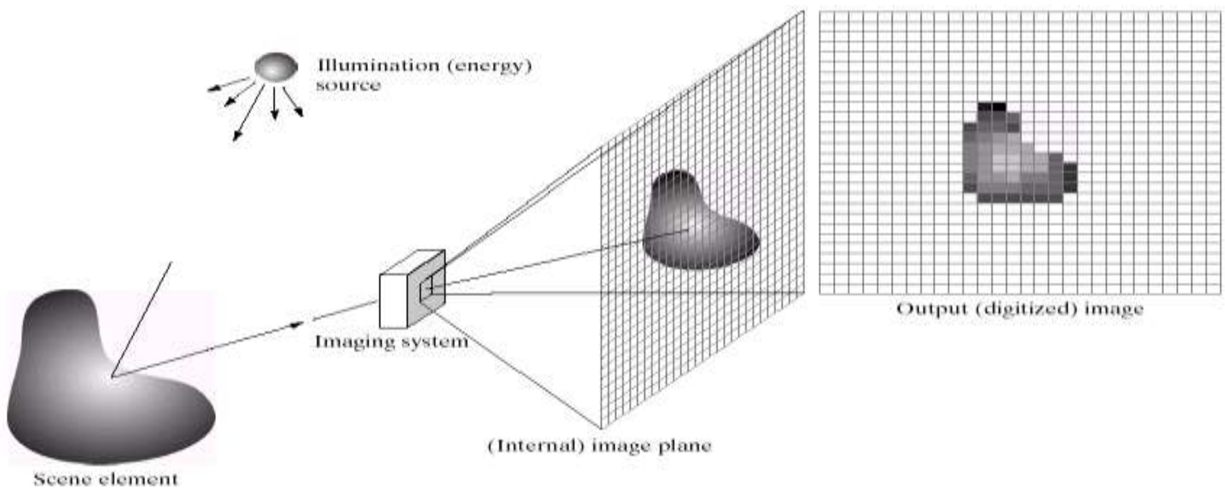


Figure 1.2 Digital Image processing in two dimensional

1.2.1 Basic Steps of Digital Image processing

Digital Image processing fundamentally comprises following three steps:

(1) First step of DIP is Importing the image with the help of optical scanner or may be by digital photography

(2) Analyzing and manipulation of the image, which comprise data compression and image enhancement.

(3) Output is the final last stage of Digital Image Processing; it gives results in the form of resultant altered image.

Digital image processing technique is divided into wide range of categories. First Category in which input and output are images and second whose input is image and output is attributes describe by the input image. All of this image processing is précised by the block diagram. Different process can be functional on image for different use and different objectives.

Low-Level Process	Mid-Level Process	High-Level Process
Input-: Image **Output-:** Image **Examples-:** Noise Removal ,Image Sharping	**Input-:** Image **Output-:** Attributes **Examples-:** Object Recognition	**Input-:** Attributes **Output:** Understanding **Examples-:** Autonomous Navigation

Table 1.1: three types of computerized processes

Interest in digital image processing stems from two principal applications areas:

1. perfection of graphic information for human understanding
2. Processing of image data for storage, transmission, and representation for independent machine sensitivity

1.2.2 Block Diagram Digital Image Processing Steps

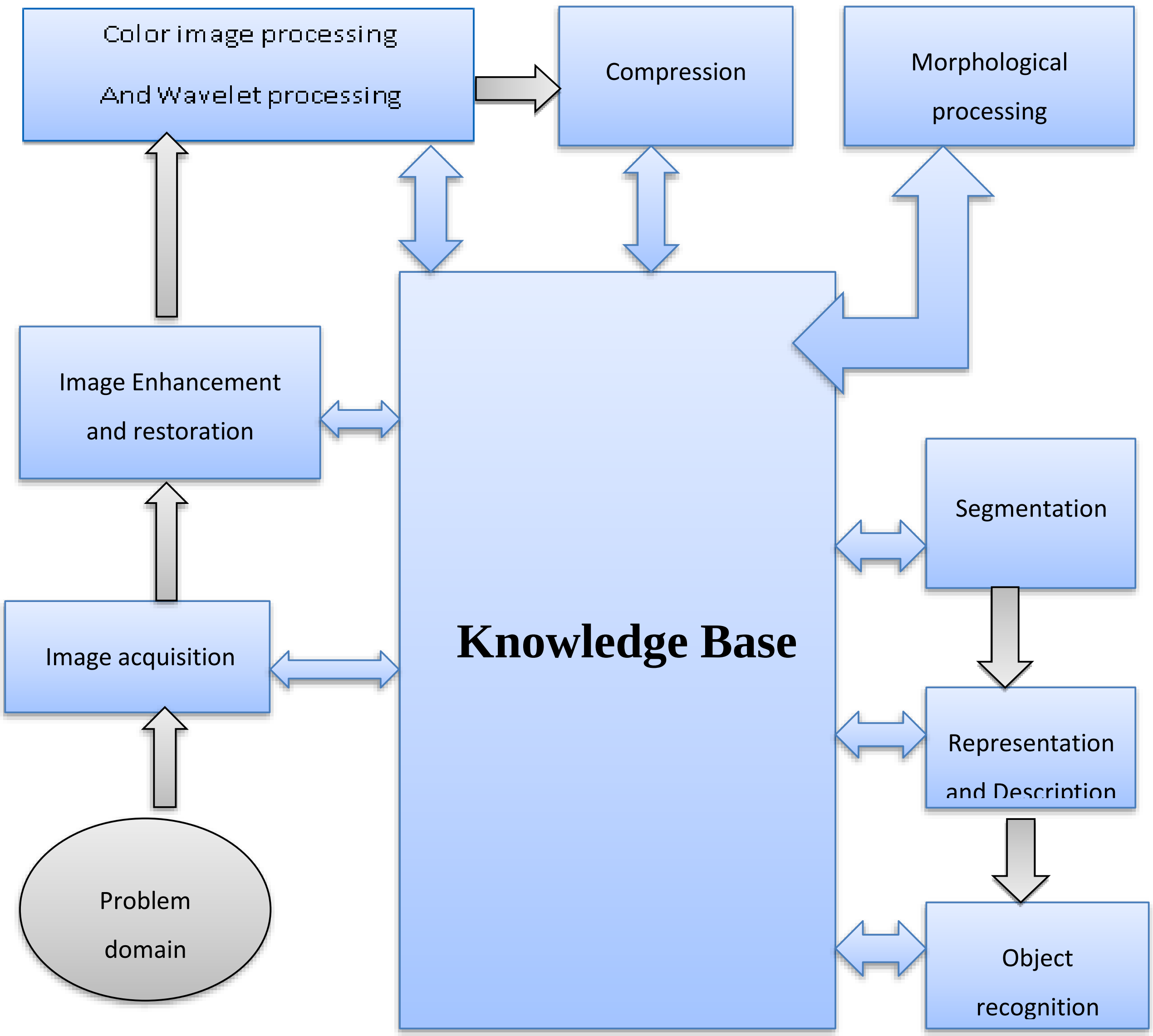
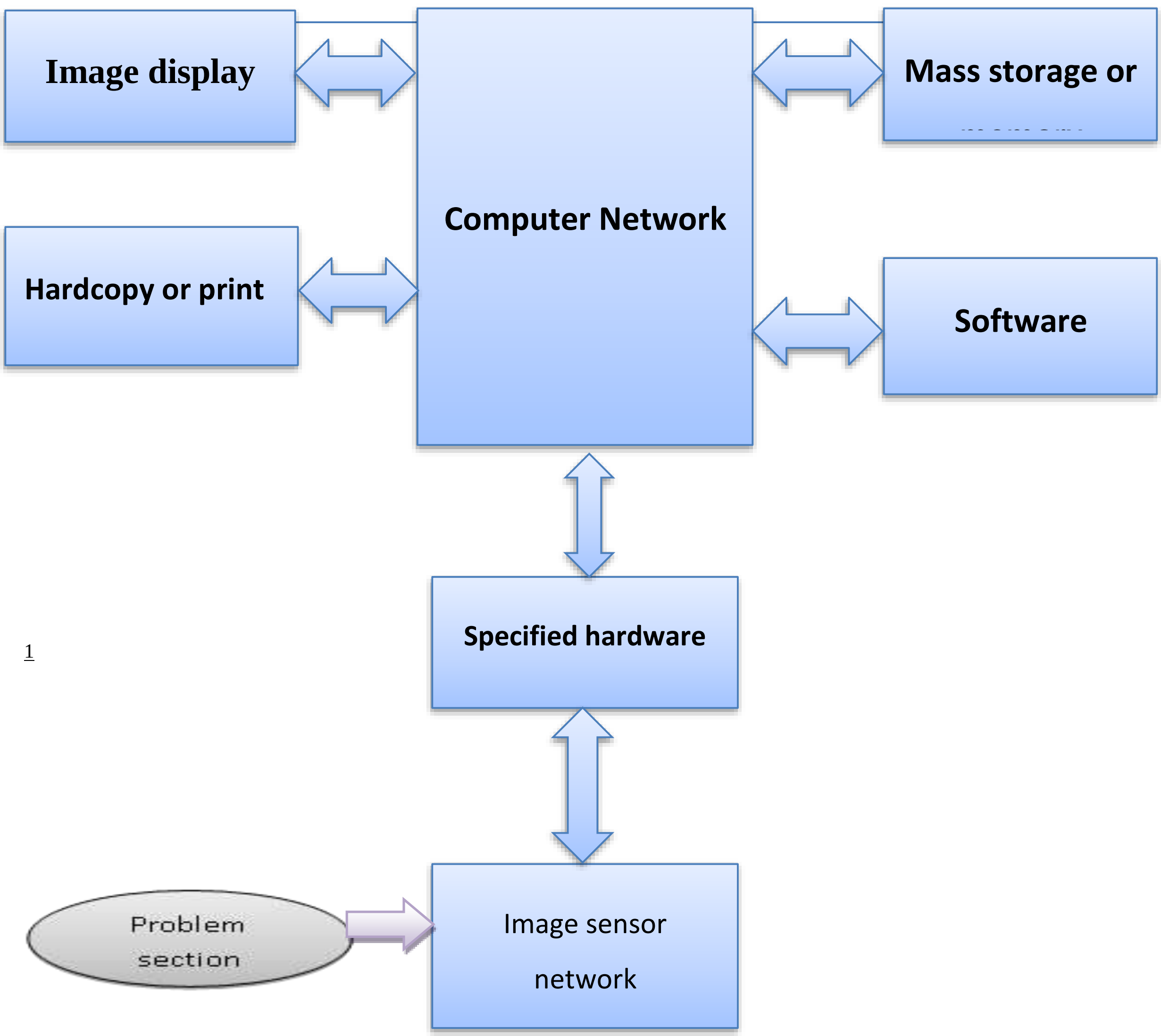


Figure 1.3 Basic Digital Image processing system steps

1.2.3 COMPONENTS OF IMAGE PROCESSING

The first step of the processing is image acquisition it obtain a digital image. for do to need following components. The purpose and working principle of each element are define below

Network Architecture



1

Figure 1.4: Block diagram of image processing components

1.2.4 Purpose of Digital Image Processing

The main purpose of image processing is allocated into five different ways as follow:-

(1) **Visualization: -** It detects the images that are not visible.

(2) **Image Sharpening and also Image Restoration:-** It is used to construct a better image.

(3) **Image Retrieval: -** Pursue for the image of interest.

(4) **Image Recognition:-** Differentiate the objects in an image

(5) **Measurement of pattern: -** It is used to extent various objects in an image.

1.2.5 Applications

The main applications of Digital Image processing are as follow:-

(1) Tracking of Moving Object

(2) It is also used in Automatic visual Inspection system

(3) It is used in Intelligent transportation system

(4) The main application of DIP is in Defense surveillance

(5) Bio medical image technique

(6) Remote sensing

1.3 Image Zooming

Zooming of an image means enlarging a picture or image in the sense to take the advantage of image detail become more clear and visible. Image zooming is the expansion or expanding of an image by a amplification factor or magnification factor but only in appearance. Image zooming is a direct presentation of image interpolation. Zooming of image used Interpolation is one of the fundamental operations in image processing. And the later quality of image after image processing expressively depends on the interpolation technique that we used. During zooming of an image there are limited parameters that we have to preserve in mind. Image artifacts e.g. blurring, jagging and ghosting may arise during processing. So the main attention on this thesis is to drop these pieces.[2]

We can zoom something in two different steps:-

1) In the first step we zoom to an image before taking its particular picture or before capture, so it is called prepossessing and it involve mechanical or hardware movement.
2) In second step we zoom to an image after image has been captured. So in this case we introduce pixels in required portion.

1.3.1 Types of zoom

There are mainly two types of zoom:

1. **Optical Zoom** -This method is linked to movement of lens of the camera. So we can say that in optical zoom lens are used to magnify an image.

2. **Digital Zoom** - Second type is Digital zoom and is related to enlargement the image by electronically. But in this case due to development of the pixels there occur problem of also pixilation/mosaic effect in the image. It is useful in case to yield a noble class zoom image.

Optical Zoom	Digital Zoom
1. It is achieved by using movement of lenses.	1. It is basically processing of image within the camera.
2. The results of Optical Zoom is more better as compared to Optical Zoom.	2. In this case pixels got expansion so its quality get affected or compromised.

Table 1.2: Optical and Digital Zoom

1.3.2 Zooming Methods:-

We are going to discuss the most common methods that are used in Digital Image Processing for Zooming of an image:-

1).Pixel Replication or Nearest Neighbor Interpolation.

2). Zero Order Hold Method

3). Zooming K times

1) Pixel Replication: - This method is also known as by the name of nearest neighbor interpolation. So from its name it is clear that we replicate the neighboring pixels. In this method we simply increase or create new pixels, we repeat each pixel n times row wise and n time's column wise, and then resultant image is zoomed image.

Row Wise Zooming of Image:-

For example if we have an image with 2 rows and 2 columns. Now we want to zoom this image by replication method so simply we will copy the pixels of its row in adjacent cell first that is Row wise zooming.

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$

Above matrix shows the original image in the form of matrix and figure below shows the matrix form for zoomed image.

$$\begin{bmatrix} 1 & 1 & 2 & 2 \\ 3 & 3 & 4 & 4 \end{bmatrix}$$

Column Wise Zooming of Image:-

$$\begin{bmatrix} 1 & 1 & 2 & 2 \\ 1 & 1 & 2 & 2 \\ 3 & 3 & 4 & 4 \\ 3 & 3 & 4 & 4 \end{bmatrix}$$

Now next step is to insert pixel by column wise, and simply we will copy the pixels in adjacent columns.

So the new image is converted from **2X2** matrix form to **4X4** matrix form.

Advantage and Disadvantage of this method:-

This method is very easy and simple to implement, but its disadvantage is that the resultant image is very blurred image.

2) Zero Order Hold Method

This is another method that is used for zooming. This method is also known as by another name that is Twice zoom. In this method we pick two elements from adjacent rows and give addition to them and result is divided by two, then that result is placed between those starting two elements. And this process is done firstly by row wise and then by column wise.

To explain this we are taking example of a image in the form of matrix

$$\begin{bmatrix} \mathbf{1} & \mathbf{2} \\ \mathbf{3} & \mathbf{4} \end{bmatrix}$$

And in Row Wise zooming we will take first two elements: (2+1) =3 and then result is divided by 2.we will get 1.5.

In column wise Zooming: We will take two adjacent column values from given matrix that is 1 and 3. We will add them that is (1+3) =4, and then result will be divided by 2 or we will obtain result 2; which is placed between them.

So now we will get new image of dimensions 3X3.

Formula Used: - (2(no of rows) minus1) X (2(number of column) minus1)

Advantage and Disadvantage of this method:-

One of the main advantages of this method as compared to previous method is that it does not create blurry image. But it will run only on power of 2.

3) Zooming K times

In this method we used two adjacent pixels values and after that there is subtraction of smaller value from greatest factor. This value is called output and output is divided by zooming factor and result is added again in smaller value, and now final value is inserted between these two values. And output value is again added to the value that we put. We have to do all this until we don't put K-1 values.

To explain this method we take an example in the form of matrix:

$$\begin{bmatrix} 15 & 30 \\ 15 & 30 \\ 15 & 30 \end{bmatrix}$$

In this case **K** is **3.** The values that we have to insert are K-1 that is 3-1=2.

In Row Wise Zooming we will take adjacent pixels that are 15, 30.Substract 15 from 30 and result is 15.Now divide 15 by **K,** so we will get **15/K = 15/3=5.**Now we will call it OP that is name by output, OP=5.

Add OP to lower number that is 15 and we will receive 15 + OP=15+5=20.

Add OP to 20 again, 20+OP=20+5=25.

We have to insert up to K-1value that is 3-1=2, so we will do this two times.

In first step it will be shown like that

$$\begin{bmatrix} 15 & 20 & 25 & 30 & 25 & 20 & 15 \\ 30 & 25 & 20 & 15 & 20 & 25 & 30 \end{bmatrix}$$

1.3.3 Important Parameters of an Image Zooming

1.3.3.1 Processing Speed –

The main parameter of Image Zooming is Speed of its processing. If speed is high then it will be capable for handle large and composite image data with speedily start-up time, faster response time and littler duration. It is main requirement of user to involve high processing speed i.e. low time complexity. Slow zooming infuriates the user. The grouping of two approaches can be enhanced the processing speed such as Image Zooming using Non-linear Partial Differential Equation.

1.3.3.2 Image Quality –

Image quality is most important factor of image. Reduced Image qualities introduce some amount of distortion in the signal. There are mainly five standard image quality assessment factors, which are discussed as follow:

1.3.3.2.1 Image Quality Factors

1.3.3.2.1.1 Sharpness –

Sharpness defines the clearness details in image. Two factors add the superficial sharpness of an image: Resolution and Acuteness.

Resolution mentions the total number of pixels in an image with dot per inch (dpi) or pixel per inch (ppi). Pixel is a minor unit of digital image and Resolution mainly linked with. If the resolution is high it means the size of pixel is small.

Acutance is the edge contrast of an image. Contrast is defined as the gap between the darkest and brightest areas of the image. Simply we can say that transition between edges. In other words we can explain contrast is an edge changes from one brightness level to another.

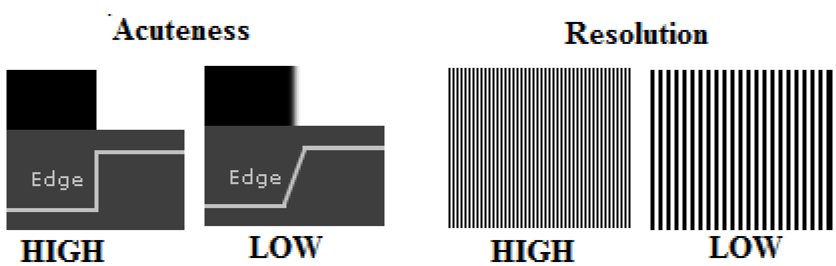


Fig. 1.5 Distinguish between HIGH/LOW Acuteness and Resolution

In this Fig.1.5 Acuteness and Resolution with their high or low level are shown. Acuteness described how speedily image change at an edge and Resolution defined a alteration between closely spaced elements of detail [2].

1.3.3.2.1.2 Noise and Distortion –

Noise signifies unsolicited material which reduces image excellence. Noise is not present in the object image but it gets introduced during acquisition processes when there is conversion of optical signals into electrical signals and then conversion into digital image. We can use Filtration method to reduce this [3].

1.3.3.2.1.3 Contrast –

It is the slope of the Tone Reproduction curve. Tone reproduction mentions to mapping of bright and dark area of an image. The Tone mapping is described by Histogram [4]. Tone distribution in digital image can be represented by Histogram that is the graphical representation.

1.3.3.2.1.4 Color:

Color is also one of the most important but unclear image quality factor. Color derives from the light. To describe any color of image we used three main qualities: *Hue, Saturation and Achromatic*. Hue defines a pure color called *red, blue, green;* determined by the wavelength [5]. Saturation is the dimension of the degree to which a pure color is diluted by white light and achromatic describes without color.

1.3.3.2.1.5 Smoothing

Smoothing is connected to median of the image. We can substitute median value at the place of Input image. Median is the middle value in the input image matrix. The primary goal of smoothing is to avoid alteration of edge component. Smoothing can be used to reduce noise [6].

1.3.3.3 Memory requirement

Zooming operations require more space so it result in high difficulty in space. Hence, an implementation of zooming operation must handle this problem effectively.

1.3.3.4 Cost:

Cost is also an important feature of image zooming. Cost grows with increasing sampling rate of image. Cost mainly depends upon the requirement of high speed and minimum memory usage.

1.4 Image Interpolation

In Image Zooming Interpolation is one of the very important factor or method. Interpolation mainly used to estimate the unidentified value between identified values. It is also perform the function of transferring image from one resolution to another without misplacing image quality. Interpolation is very important in Image processing field and for image zooming, enhancement of image, resizing any many more applications. This is basically derived from Latin verb interpolate, that is a retrenchment of two words *"inter"* means between and *"polare"* means to polish [7]. In fig. 1.3 we will explain how resizing or enlargement works in image. Here the original image matrix and the effect with before interpolation, after interpolation and no interpolation techniques.

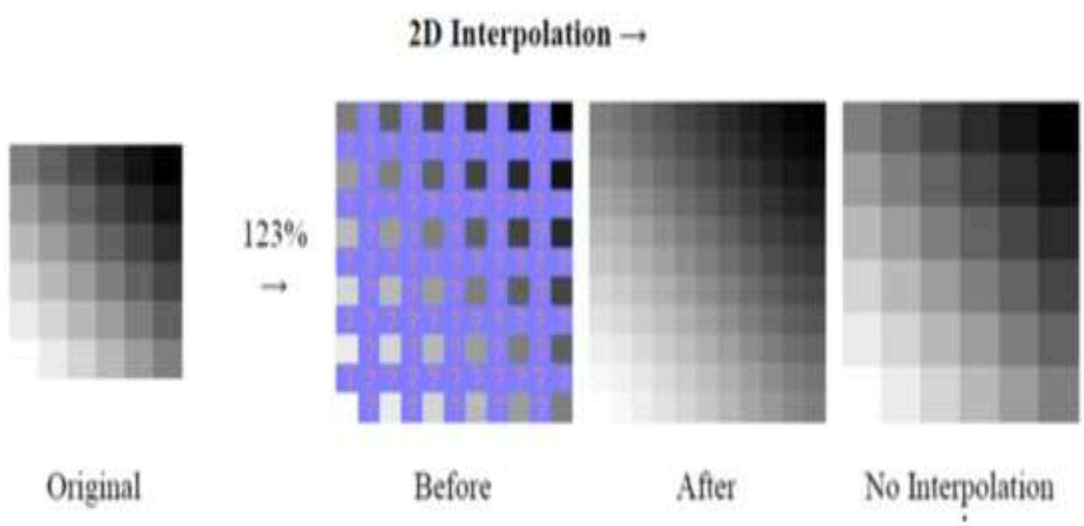


Fig 1.6 Resizing/ enlargement works

We do the Digital image interpolation for the purpose of the retrieval of a continuous intensity surface from discrete image data samples. For illustration, if we take the examples of digital camera HR and LR then HR cameras digitized scenes at abundant finer scale as compared to LR and it contain more info than LR cameras. But we are not able to store all pictures and images at HR due to memory, equipment in the case of the Internet, bandwidth limitations.

But by using LR images in interpolation algorithms it gives end-users magnified images of advanced resolution for printing, viewing, and creating, editing.

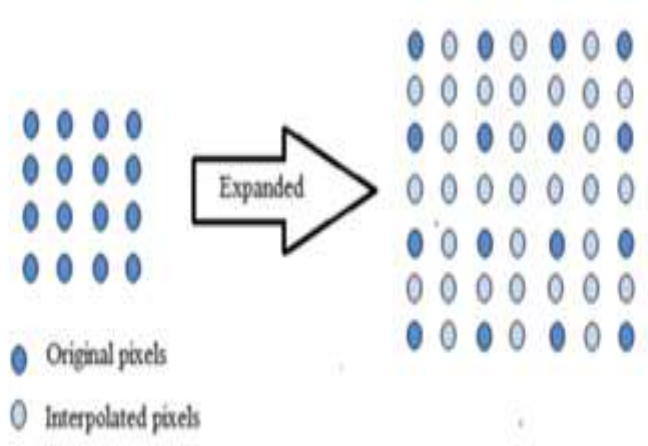


Fig 1.7 Basic interpolation Concept

The interpolation suggests smoothing in between given pieces of information. For image zooming we also used resampling technique. But for an image to be resampled, first of all we will us interpolation which is used to transform the discrete data into continuous function. And in the second step sampling produces discrete image. If after sampling size of an image increased then this is called up sampling, and if size of image get reduced it is called down sampling.

Figure 1.4 shows a basic interpolation concept. In this figure, we have a 4*4 image that is converted into 8*8 images by inserting interpolated values between the original pixels. In this figure we are using two types of circle to represent pixels one are Dark blue circle describes the existing pixel values and light blue circle describes inserted blank pixel position or interpolated pixels.

If we will study different research area then there are many different methods of image zooming but in this thesis we will discuss mainly about only three methods, then we will analyze and compare these methods based on their PSNR (Peak Signal to Noise Ratio). To compare the quality of zoomed image with respect to original image by different method PSNR is used and is characterized by Mean Square error (MSE). Mean Square Error is also one of the important parameter to quantify the difference between original image and zoomed image. We can say that Mean square error (MSE) is degree of image distortion and it presents the overall gray-value error contained in the original image and zoomed image.

1.4.1 Techniques of Interpolation

There are mainly two types of Interpolation methods:

1. **Global Interpolation-** This method mainly depends on a creating single equation that can fit at all the data points. This equation is frequently a high degree polynomial equation. The result of this method is smooth curves. This method accounts all known points to estimate the values at unknown locations. [3].

2. **Local Interpolation-** This is one another method that depends mainly upon constructing a polynomial of low degree among each pair of known data points. Another type of this is linear interpolation, if a first degree polynomial is used. And if second and third degree polynomials used then this is named as, quadratic and cubic splines respectively.

This method studies a fixed number of points, such that points within a certain distance (search radius) to the point being estimated.

1.5 IMAGE INTERPOLATION CATEGORISED AS:-

Image interpolation techniques are mainly categorized into 3 broad types:

1.5.1 Linear Techniques:

When linear polynomials are used to fit a curve that method is called linear type. In this method rate of change of known values is represented by a straight line. It can be calculated from these values using a simple slope Formula (eq.1.1).

$$F(x) = a_0 + a_1x + a_2x_2 + \ldots + a\,(n-1)\,x\,(n-1) \ldots\ldots\ldots\ldots\ldots\ldots \quad (1.1)$$

In this method block boundaries or edges appears as discontinuity along. One another method of this is Bi linear interpolation that is more effective for minimizing block boundary and preserve edges. There is one another method i.e. combination of linear interpolation, and two interpolators (zero-order and bi linear) and called as Fuzzy concept. To extract the edge information of the image, a Fuzzy concept is used.

Fuzzy systems are commanding tools for representation and processing at an image.

For fine detail of an image, we used one another method by name Space variant linear interpolation that is mainly based on the assessment of a “warped distance” among the pixel to be projected and each of its neighbors. This warping procedure is done by affecting the estimate of the pixel towards the more homogeneous neighboring side. This algorithm leads toward better results as compared to other, but it introduced noise.

1.5.2 Nonlinear Techniques:

When we need to develop a smooth curve between two or more points we will use nonlinear interpolation and these smooth curve called spline [4-5]. This Interpolation based upon constructing a polynomial of low degree among all pair of known data points. If a first degree polynomial is used, it is called linear interpolation, but if polynomials are of second and third degree then it is called quadratic [18] and cubic splines [19] respectively.

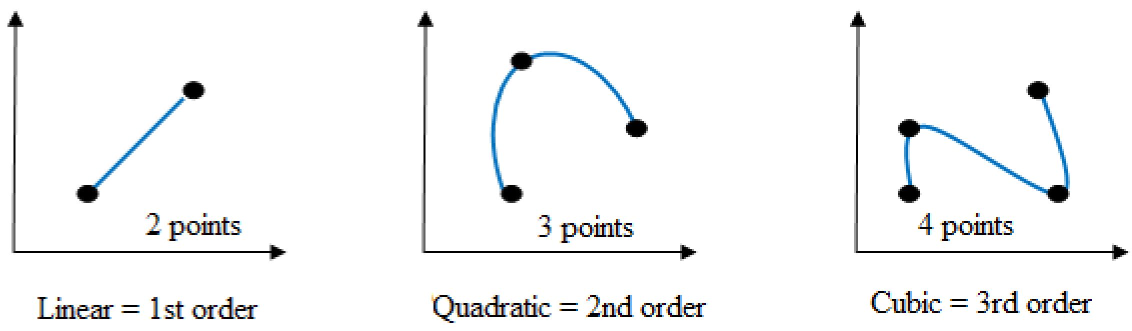


Fig.1.8 Curves of Linear, Quadratic and Cubic Spline Polynomial

In fig.1.5, shows the 1st order, 2nd order and 3rd order curves. The General Formula of (n-1)th order Polynomial.

Transform Techniques Used In Image processing:

We use the Transform techniques mainly to transform or to modify image and with help of algebraic equations. There are different types of transforming techniques:

1.5.3.1 Discrete Cosine Transform (DCT) – When we convert a signal into frequency components then that method is called The Discrete Cosine Transform (DCT). This method is broadly used in image compression. DCT includes the use of just cosine functions and real coefficients.

The forward 2D_DCT transformation is given by the following equation:

$$\mathbf{C(u, v) = D(u)D(v)\sum_{x=0}^{N-1} \quad \sum_{y=0}^{N-1} f(x, y)cos[(2x+1)u\pi/2N]cos(2y+1)v\pi/2N] \ldots\ldots\ldots (1.2)}$$

Where u, v= 0, 1, 2, 3, …………… , N-1
x, y = spatial coordinates

The inverse 2D-DCT transformation is given by the following equation:

$$\mathbf{F(x,y) = \sum_{u=0}^{N-1} \sum \sum_{v=0}^{N-1} D(u)D(v)\ D(u,v)cos[(2x+1)u\pi/2N]xcos(2y+1)v\pi/2N]..1.3}$$

1.5.3.2 Discrete Wavelet Transform (DWT):

Next method is the Discrete Wavelet Transform (DWT). DWT are used to multi resolution representations of an image signal. When we need to decompose image signal into multistate details we will use DWT. It decomposes the image into 4 parts and these parts are called sub-bands.

Name of these sub–bands are given as: LL (low-low), LH (low high), HL (high-low), and HH (high-high) as shown in fig.1.6. This decomposition of images at first time is called 1st level decomposition. And if we decompose one of the sub band from these four sub bands into four other sub parts then these parts are called LL1, LH1, HL1 and HH1. And this decomposition step is called 2nd level decomposition. This process is applied at whole image so the complete image is converted into small units from nth level decomposition method with discrete wavelet transform [21].

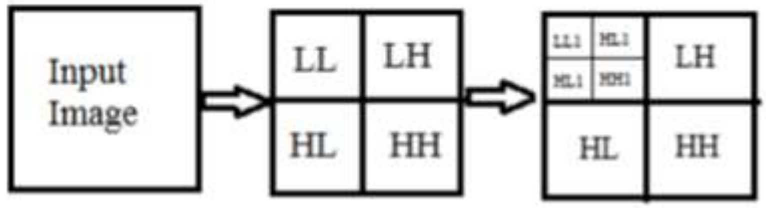


Fig1.9 Image decomposition with discrete wavelet transform

1.5.3.3 Laplace Transform:

This Transform method is an integral method which is used mainly to transforms normal or Partial differential equation (PDE) into a simple algebraic equation without using any type of derivation[4]. **Laplace Transform** is a method used to solve differential equations. We use finite difference schemes to solve the difference equation.

There are mainly three ways to calculate Finite difference - **Forward difference, backward difference and central difference.**

The difference between two numbers simultaneously in forward direction is called **the forward differenc**e. It uses Newton and Taylor formula. Interpolation is a technique to create new data through multiplication of input and impulse response signal.

1.5.3.4 Fourier Transform:

When we use both Sine and Cosines Function that is called Fourier Transformation. Fourier transform is mainly convert data from a spatial domain into a frequency domain

There are two types of Fourier transform:

1.5.3.4.1 Discrete Fourier Transform (DFT):

When our main need is to determine the harmonic or frequency content of image signal we use DFT. To obtain DFT of image we perform the sampling operation in both time and frequency domain.

1.5.3.4.2 Fast Fourier Transform (FFT) – FFT is also based on the decay of the DFT computation by creating lesser and lesser subsequences

1.6 QUALITY EXCELLENCE CALCULATION

If we want to check the results and quality of different methods then, firstly we will take a test image and it will be zoomed out with different scale parameters At last the zoomed image will be compared by two aspects: Subjective and Quantitative.

1.6.1 Subjective:

Subjective class is a characteristic to represent quality assessment. It is mainly concerned with how a video or picture is supposed by a viewer, in this method people watch and view the image. It is extra appropriate to appraise the zoomed image quality with subjective methods

1.6.2 Quantitative:

When we want to measure quantity of ant method we used different method or algorithm.

1.6.2.1 Mean Absolute error (MAE):

This is error of absolute rate of the alteration between Zoomed image and Original image. If there is lower value of MAE then it indicates higher accuracy in image [5]. The mean absolute error is calculated by the formula as given below:-

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

1.6.2.2 Mean Square Error (MSE):

MSE is used to calculate the standard deviation of error signal .It is lower rate for smooth image [27].The mean Square error is calculated by:

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

m, n –Coordinate points

I – Original image

K –Zoomed image

1.6.2.3 Peak Signal to Noise Ratio [PSNR] - the ratio of maximum power of a signal and the power of noise signal of its representation is called peak signal to noise ratio.[15] This ratio is mainly used for quality measurement between original image I and zooming image K.

It is expressed in terms of the decibel

We can define the PSNR as given below:-

$$PSNR=10.\log 10\frac{(MAX)2}{MSE}$$

$$PSNR=10.\log 10(\frac{(MAX)}{\sqrt{MSE}})2$$

$$PSNR=20.\log 10(\frac{(MAX)}{\sqrt{MSE}})$$

Where

MAXI =maximum pixel value, (2B-1)

B= bits per samples

MSE = means square error

CHAPTER 2

LITERATURE SURVEY

Chapter-2

LITERATURE SURVEY

2.1 Introduction

Previous to start my thesis, it is very imperative to have a bottomless understanding and knowledge on the Interpolation technique. One of the major bases of information and knowledge for the dissertation and research are books, journal, thesis and dissertations and the internet also. The most important areas for reading of literature depend mainly upon three area that are Types of Interpolation, overview on Interpolation, and related Mat Lab software that we are using. The papers that we studied for our research are as referred are mainly for image processing application using various techniques like Bilinear, Bicubic and Nearest Neighbor.

2.2 Research Paper Literature Review

Before starting our work the first step is to study the previous published research papers and to gain knowledge about past work that is done by other researchers in this area.

With the support of literature analysis, it will become easy for us to carry out this work. The thesis work mostly involves the image Interpolation methods of zooming. As we found that already a lot of work has been finished. But still our methodology is to find a better zooming algorithm by studying all the work earlier done. So now we are going to start from the literature survey of the previous practices.

The thought of Interpolation was first suggested in 18th and 19th century. Equidistant Data formula was studied from Newton's theories in which we are supposing that we are given measurements of some quantity at $\mathbf{x_0, x_0 \pm T, x_0 \pm 2T \ldots\ldots}$ and that in order to find its rate at any intermediate point $\mathbf{x_0 \pm \alpha_0}$. We locally model it as a polynomial

$$\mathbf{F(x_0 \pm \alpha_0) = f(x_0) + \alpha \triangle f(x_0) + \frac{1}{2!}\, \alpha\, (\alpha - 1)\, \triangle^2 f(x_0) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.1}$$

Stirling, Gauss, Euler, Lagrange, Bessel, Laplace further studied these theories, and the developments until the end of 19th century had been remarkable,

In 1885, Weierstrass also resolved the use of approximations by approximation theorem, which outlines that on a closed interval every continuous function can be approximated uniformly to any prescribed accuracy by a polynomial. But those methods takes long execution time for high speed application, so to overcome these problems in the 20th century theory is introduced that is interpolation theory. Zero-padding', `Sinc interpolation', ` and `Fourier transforms' are commonly used parameters by the image processing.

Lung-Jen Wang, Wen-Shyong Hsieh, Trieu-Kien Truong, Irving S. Reed, and T. C. Cheng*, ' A Fast Efficient Computation of Cubic-Spline Interpolation in Image Codec'*.[4]

Spline passes over the given data points. They create a connection among the known data points and the unknown coefficients that used to wholly specify the spline. The coefficients may be resolved in terms of the first or second derivatives. Once the coefficients are expressed in terms of either the first or second derivatives·, these unknown derivatives must be determined.

This paper presents idea of encoding and decoding process with cubic spline interpolation. It needs significantly fewer additions and multiplications than the original CSI algorithm. Additionally, a new form of overlap-save system is operated to solve the boundary-condition problems that arise between two neighboring sub images in the actual image. This method used a very effectual nine point Wino grad discrete Fourier transform. This scheme requires less computational time. The speed of the new method is approximately two times faster than that of bilinear method. Based on this CSI scheme, a new, faster, and efficient algorithm for cubic-spline interpolation invented that is called the fast cubic spline interpolation (FCSI).FCSI significantly decreases the difficulty of the additional calculations required for the increased compression ratio.[4]

Rukundo Olivier, Cao Hanqiang presents *'Nearest Neighbor Value Interpolation'* [14].

In this paper nearest neighbor algorithm is explained for high resolution image. This thought is very valuable if we consider the case of speed. Mainly three steps are used in this paper by Authors -

1) First step is the Neighbor mode calculation,

2) In second step Difference mode calculation is done and

3) When no difference mode.

Mode is the value that arises normally in a data set or a probability distribution. In the first step author check whether, there is a mode or not. If any mode occurs here then, the blank place will be allocated that mode. And if the mode does not happen then, we continue to execute the bilinear interpolation data in order to achieve a bilinear interpolated value. Once the bilinear value is found, we do the deduction processes from four pixels and bilinear value. At second phase, the value is considered through minimum or maximum data. we can find the neighbor if the minimum value or maximum value is attained. Then Calculation for the absolute difference between that value and bilinear value is done, and this value is assigned to the blank position. At

When there is no difference mode then this the third stage , and now we have to find the minimum value *using* mat lab *min* function. As soon as the minimum value is attained, we must find the neighbor. This can be reached by deducting the smallest variance from the bilinear value. Then, the attained value is allotted to the blank position. Authors verified this algorithm with PSNR. The future image tends to look sharper than original image. The Higher PSNR was used to prove through the calculations which one has really higher quality than original image.[14]

Ranjeet Roy, Maninder Pal and Tarun Gulati present '*Zooming Digital Images using Interpolation Techniques*' [15]

In this paper Zooming is done by nearest-neighbor interpolation function that has a rectangular shape in frequency domain. Because the rectangular pulse of Fourier Transform is correspondent to a *sinc* function .But in sinc function it has logarithm side lobes and due to this its gain in pass band falls off quickly so poor image quality found. Those side-lobes typically give outcome in aliasing and blurring effects in the interpolated image. In order to examine the features of the nearest neighbor are applied in Mat lab. So as a result, the nearest neighbor function does discreetly well in the pass band; however, has moderately higher side lobes in the stop band.[15]

Sudhir Sharma, Asst. Prof. Robin Walia presents, '*Zooming Digital Images using Modal Interpolation'* **[17]**

From this paper we found that, zooming operation combines nearest neighbor and bilinear method. In this method, an image is magnified by (2n-1*2n-1) times from original image (m*m). The first phase is to figure out the method of the four nearest neighbor pixels A, B, C, and D and then these four pixels are kept in array called DS (dataset) and after that mode is calculated. Here the meaning of mode is the value that happens most regularly in data set. Algorithm applies the nearest neighbor, if mode exits in the data set, and then it allocates the mode value to that blank location. And in case if the mode does not occur in DS then, to determine the value of the empty new pixel the bilinear interpolation is performed on the DS data (E). And there is subtraction of bilinear value (BV) from each pixel value in date set (DS), as:

NDS= [NV1, NV2, NV3, NV4] = [|A- BV|, |B- BV|, |C- BV|, |D- BV|] **.**

The values (NV1, NV2, NV3 and NV4) attained, from the subtraction processes. This new data set (NDS) is once more considered to find if the new complete value is equal to alternative or simply arises most frequently. In order to find the one neighbor whose rate is nearly equal to the value produced by the bilinear interpolator? This is completed as per the boundary conditions.

Minimum mode value Example*:* NDS= [0.1, 0.1, 0.1, 0.7]

In this instance, take minimum mode value (0.1) in data set and then subtracted from its bilinear value or the total of this variance is allocated to the unfilled pixel.

Maximum mode value, Example*: NDS= [0.1, 0.7, 0.7, 0.7]*

In this instance, take maximum mode value (0.1) in data set and then it is deducted from its bilinear value and the total of this difference is allocated to the unfilled pixel.

Zero mode Example*: NDS= [0.1, 0.1, 0.7, 0.7]*

In *Zero modes*, there is no mode if the two data/elements of a set replicate the similar number of times. In this case, the first least value is measured and value attained by deducting the least variance from the bilinear value, since the least value is equal to the neighbor value minus the bilinear value. And then this value is allocated to the unfilled location.And all the results are calculated in terms of visual appearance and from PSNR. This procedure gives moderately advanced values of PSNR and better visual appearance.[17]

S. Battiato, G. Gallo, F. Stanco presents A locally adaptive zooming algorithm for digital images[19]

This paper presents the problem of enlarged image from given digital image by zooming. This gives the idea about discontinuities or luminance variation during doubling the input original image. The algorithm which is used mainly worked on monochromatic image. This method was in comparisons of pixel replication and simple interpolation method. The elementary indication of this algorithm is to do a weighted interpolation, gradient-controlled. This technique speed up the whole adaptive process without requiring a preliminary gradient computation since the relevant info is composed throughout the zooming process.

First step (n x n) pixels are expanded into (2n-1) X (2n-1).There are some undefined value of all the pixels in original image with at least one even coordinate .In the second stage the algorithm scans line by line the pixels in original image, And for each pixel some conditions to be tested and an action is taken.

If a, b, c and d represent the value of luminance of pixel then value that assigned to pixel is (a+b+c+d)/4. After these two stages there is one another stage that scans for the pixels that remain undefined in 1st and 2nd stage. And then all the holes are filled or we can say that empty pixels are filled. In next step they filled the pixels in empty spaces between rows and columns. And the results obtained by this method is more comparable as compared bicubic interpolation

.

Yu-Chen Hu, Bing-Hwang Su, Wu-Lin Chen and Wan-Yu Lu presents, '*Image Zooming for Indexed Color Images Based on Bilinear Interpolation' (20)*

The bilinear interpolation method is a commonly used method for image zooming. It works well for the smooth areas zooming, but we can found some blocking artifact in the edge boundaries of the zoomed image when we used bilinear interpolation technique. In this paper, the proposed scheme, the bilinear interpolation method is working to expand the original image. Then, the pixel grouping process is executed Firstly, the color image is first decoded to generate the decoded image *DI* of $w \times h$ pixels. Then, the bilinear method is employed to enlarge *DI*. Afterward the bilinear interpolation is performed; the enlarged image *EI* of $W \times H$ pixels is generated.

The resemblance between the original image and the enlarged image is equated. From the experimental results, it is displayed that the proposed system offers better image quality.

2.3 Conclusion of Literature Survey-

In this study, we come across various interpolation approaches for image zooming and they are mainly nearest neighbor, bilinear interpolation, Bicubic Interpolation and Modal Interpolation. These interpolation approaches are used in Image Zooming technique. Nearest neighbor is a most simple technique but its results produce blocky image. So to reduce this blocky effect bilinear interpolation is used. And if speed is not main concern then we can use Bicubic interpolation.

2.4 Problem Statement

The applications of image zooming is used in many fields like scientific visualization, multimedia applications and image analysis tasks. A general image zooming algorithm takes as an input a digital image and delivers an output picture of essential magnitude and conserving as much as probable the info of original image. There are so many good zooming techniques are available. Out of these methods some interpolation techniques are (NNI) pixel replication, bicubic and bilinear are the most widespread varieties and employed in marketable digital image processing software. After the study of the literature, we can expand image to any magnification factor by using Image zooming.

But during expanding procedure Image missed their resolution details and produces image artifacts like ghosting, blurring, jagging etc. I have found that some artifacts continually occur when the image is zoomed by using any of interpolation procedures. These artifacts occur in different form by different method such like jagging- blocks are molded because of replication of pixels and blurring. One of the main causes of the artifacts is the occurrence of boundaries in an image. Once an image of edges is zoomed, those edges are not resized appropriately. And these may reason the blurring in the zoomed images. So we have to consider the occurrence of image edges however zooming the images. Till to date many authors have worked at these methods and now they are trying to decrease their image artifacts to give a high resolution image.

CHAPTER 3

Algorithm and Interpolation Section

Chapter-3

Algorithm and Interpolation Section

3.1 Algorithm Section

We can group the Common interpolation algorithms into main two categories:

1. Adaptive Algorithm
2. Non Adaptive Algorithm

Adaptive algorithm methods make a modification depending on the factors like what they are interpolating, while in second case non-adaptive methods treat with all pixels similarly.

3.1.1 Non-Adaptive Algorithms

Non adaptive interpolation algorithm performs interpolation by static design for all pixels. This algorithm has the advantage of low calculation cost and easy to perform. Because of their complication, during interpolation these use anyplace from 0 to 256 (or more) adjacent. If it requires more adjacent pixels, it can become more correct, but for this work it will require much longer processing time and it will become more expense. For the purpose of distort and resize a photo we used these algorithms. Non-adaptive algorithms are:

1. Nearest Neighbor

2. Bicubic Smoother

3. Bicubic Sharper

4. Bicubic

5. Bilinear

6. Lanczos

7. Bilinear b/w blur

3.1.2 Adaptive Algorithms:

Second types of algorithm for interpolation is introduced as Adaptive interpolation, it evaluate lost pixel values and provide improved image than non-adaptive algorithm [15]. But, it consumes a lot of calculations for interpolation. Several of these apply a diverse form of their algorithm (on a pixel-by-pixel basis) once they perceive the existence of an edge aiming to minimalize unsightly interpolation artifacts in areas where they are most apparent. The main motive of these algorithms is to maximizing the artifact-free detail in enlarged photos, so some cannot be used to change or rotate an image.

Adaptive algorithms are:

1 Nearest Neighbor

2. Bicubic

3. Genuine Fractals

4. Photo Zoom

5. Smart Edge

3.2 Interpolation Methods

The process by which a small image is made larger is called Interpolation. Software tools mainly used to expanse the size of the image and to create pixels to fill in the blanks. Interpolation is the approximation of values in a function between well-known points. Interpolated images produce smoother lines and improved large print as compared to the original image. Here are numerous basic function-fitting or interpolation approaches, with pixel replication(NNI), bilinear interpolation.

3.2.1 NNI

NNI stands for Nearest Neighbor Interpolation. NNI is humblest zooming method. Proximal interpolation is also known as by the name of NNI. NNI choose the rate of the nearest point to the specified input coordinates, and allocates those values at the unfilled place by copying the pixel value. The NNI method does not generate a new value, it just replicas present values. Uniform weights is the basic parameter that is used in nearest neighbor's classification that is, the value calculated from a modest majority vote of the nearest neighbors. Several authors have used this method with different approach. Conquer, Divide and Combine

- **Conquer**: -

  It means to solve the sub-problems by solving them recursively. This states that if a sub-problem is very small, then we solved it in a straightforward manner. Sort the two subsequences recursively using merge sort.
- **Divide**

  It means division of the problem into a number of sub-problems i.e similar to the original problem but smaller; the n-element sequence to be sorted into two subsequences of n/2 element each.
- **Combine**

  It is the combination of solutions to the sub-problems into the solution for the original problem. It will merge the two sorted subsequences to produce the sorted answer.

3.2.1.1 Extraction of NNI method

When we want to expand an image by any integer number of times i.e. we want to double, triple, quadruple etc. we can use Nearest Neighbor Interpolation. In this NNI method we repeat the pixel value according to the zooming number. For example if we have an image X and we want to zoom these images by 2X. X is an original image matrix. Then the process is explained as following example.

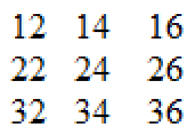


Fig.3.1 Original Image

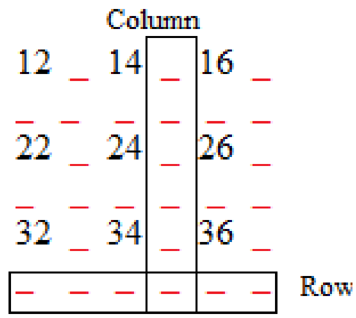


Fig.3.2 Insertion of Blank Pixel

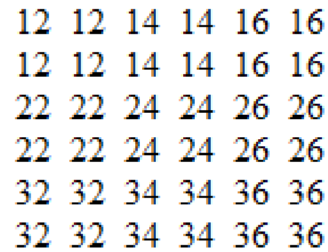


Fig.3.3 Filling Blank Pixel

In fig.3.1 there is an image matrix and made by number of rows and number of columns. Now, we will recognize their size. From the image matrix we found that number of columns is 3 and number of rows is 3.So we can say that the size of an image matrix is 3*3. Now if we want to increase the number of columns and no. of rows in twice. We will found new matrix image of number of columns and number of rows will be 6*6. After classifying their size, we need to zoom it. In order to zoom this image first step always will be to insert blank pixels between each rows and columns. These empty pixels always created by MATLAB command *zeros*. Therefore we will insert blank pixel according to fig.3.2.In next step after insertion of blank pixel, we will fill the blank position by some particular values. In order to fill the blank pixel we take first value 12 to copy this value at nearest blank position in row. Again we will take 14 as next second value and copy this value at nearest position in row as same as previous. This procedure will remain continue till the end of row. Now in this way we have completed first row. This same row is again copy at nearest blanked row, and we are completed with two rows. In third row, we will take again first value 22 and copied it at nearest blank position as same as according to previous method. So the procedure will be continual till the end of columns. And now we are with the resulting image that is larger than the original image, and it preserves all the original detail, but has some undesirable noise.

3.2.1.2 Pseudo Code of NNI:

Step1: Input original image.

Step2: Convert original image into a matrix form. Matrix form is created by MATLAB command such as

A=imread (‘zoom.jpg’)

In this case *imread* is a command for identify an image matrix. The image name is written in inverted commas with extension like that ‘zoom.jpg. A is used to store the image matrix.

Step3: MATLAB command *size is used to* identify their size through

C=size (A)

Size command is used to calculate the image size.

C is used to store the output of size command and size like that 3*3 etc.

Step 4: Enter the zooming number through *input* command.

D= input (‘enter zooming number’)

This command is used to enter zooming number and store in D.

Step 5: Insert blank pixels according to zooming number by *zeros* command.

E=zeros (1, D)

This command is used to create blank pixel according to the condition like that starting from 1 up to D.

Step 6: Take a first value and copied it at nearest blank position in row till then end of row. Fill all the blanked pixel positions with their nearest value.

Advantage- The biggest advantage of this method is high processing speed.

Disadvantage- It suffers with an apparent problem of low picture quality and blocky image.

CHAPTER 4

Proposed Work

CHAPTER 4

Proposed Work

To improve image and produce a high resolution, we will use bilinear interpolation technique with MATLAB. We will try and work to expand an image and to relate with existing parameters. We will try to increase PSNR of zoomed image as compared to other existing methods.

BILINEAR INTERPOLATION

4.1 Introduction

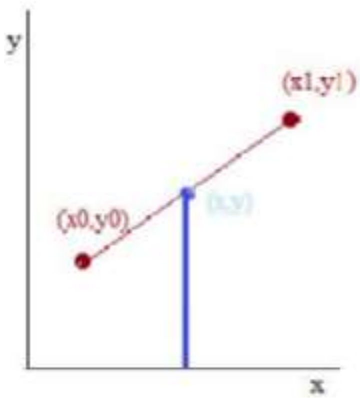
Adaptive Bilinear Interpolation Method

We studied about the nearest neighbor interpolation from the different research paper and found that it uses the pixel replication from the nearest location. The problem involved with NNI technique is bypassed by using bilinear interpolation. Bilinear interpolation technique contains by two simple linear operations. Mainly It is a simple linear operation in both x and y directions.

Bilinear Interpolation Technique is sensibly profligate and it does not agonize from blocking artifacts which are present in Nearest-Neighbor Interpolation. Bilinear interpolation is the very simplest technique of receiving values at locations in amongst the data points. The points are simply combined by square line segments. Each segment can be interpolated independently. Bilinear interpolation also controls the grey level after the weighted average from the four neighboring pixels to the specified input coordinates and it allocates that value to the output coordinate. Then bilinear takes a weighted average of 4 pixels in the original image I nearest to the new pixel location. This method produces an image of smoother presence as compared to nearest neighbor method. In this method we obtained the image that is less “blocky” to 4 times.

4.2. Extraction

Adaptive proposed method calculates an output grid from the values of the four nearest points, based on the weighted-distance to these points. In this method, we fill the interpolated point with four neighboring pixels of weighted average. First we perform linear interpolations in horizontal direction and second in vertical direction.



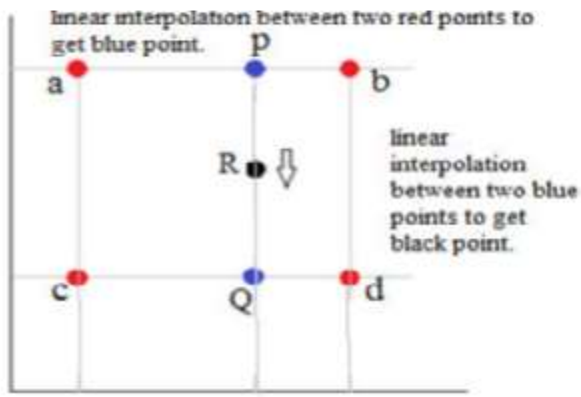


Fig.4.1 Liner interpolation fig.4.2 Bilinear Interpolation

Assume that two well-known coordinates (x0, y0) and (x1, y1) are given in fig.4.1. And we calculate the unknown value is in given x axis by using following formula of linear interpolation.

$$Y = Y_0 + (Y_0-Y_1)*(X-X_0)/(X_0-X_1)$$

Fig.4.2 states the bilinear interpolation technique by means linear operation in two times. Let's suppose that a, b, c, d are the well-known coordinates indicated by (Red points) and find out R unknown point indicated by (black point). To calculate this point, we will conduct two processes first we will calculate horizontal points P, Q (blue point) with the help of a-b and c-d. Then we will calculate vertical point R (black) with the help of P and Q points. The Bilinear Interpolation uses two linear interpolation methods. This procedure generates a weighted average value that is used to fill in the empty places. Bilinear interpolation technique used the nearby 2x2 known pixel values nearby the location of unknown pixel and associates a weighted average of these 4 pixels to arrive at its final, interpolated value.

In this method we defined 'P' as the intensity of the zoomed image. And P is the weighted sum of the mapped 4 neighboring pixels. If we will use 'scale' as a zooming factor, then we will use 'r' and 'c' for the mapped pixel point in original image.

$$r = \text{floor}(x/\text{scale})$$

$$c = \text{floor}(y/\text{scale})$$

If we have to calculate the distance from the point of interest to mapped pixel we will use formula as follow:-

$$X_{int}, Y_{int} = \{\text{rem}\,(\frac{x}{scale},1), \text{rem}(\frac{y}{scale},1)\}$$

By using all these formulas we are able to defined neighboring 4 pixels as

$$P_{topLft}, P_{topright}, P_{botlft}, P_{botrght} = \{f(r,c), f(r+1,c), f(r,c+1), f(r+1,c+1)\}.$$

ALGORITM:-

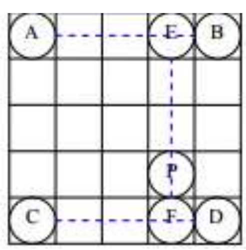


Fig 4.3 :- bilinear interpolation

Let's Assume the A, B, C and D respectively (i, j) , (i, j + 1) , (i+ 1, j) and (i+ 1,j + 1) be the coordinate, and the coordinate of P is (u,v). The main three steps of bilinear interpolation algorithm are:

Step 1: In first step we have to calculate the influence of A and B and denote it as E.

$$F(i, j+v) = [f(i,j+1)-f(i, j)]v + f(i, j)$$

Step 2: In second step we have to calculate the influence of C and D and denote it as F.

$$f(i+1,j+v) = [f(i+1, j+1) - f(i+1, j)]v + f(i+1,j)$$

Step 3: to calculate the influence of E and F and denote it as P.

$$f(i+u, j+v)= =(1-u)(1-v)f(i, j)-(1-u)v f(i,j+1)+u(1-v)f(i+1,j)+uvf(i+1,j+1)$$

Bilinear interpolation is one of the simple techniques in image processing. It is also named as bilinear filtering. To map a screen pixel location to a corresponding point we used an algorithm. A weighted average of the attributes of the four surrounding pixels is computed and we calculate an average of four pixels a, b, c and d and then applied to the screen pixel. And a scale factor is used to enlarge image. In our purposed method we used different scale factor or magnification factor ranging from above to 1.After an image is to be scaled up, every pixel of the original image must to be moved in a definite direction based on the scale constant.

4.3 Pseudo code of Bilinear Algorithm:-

Step1: We assume Input original image "I".

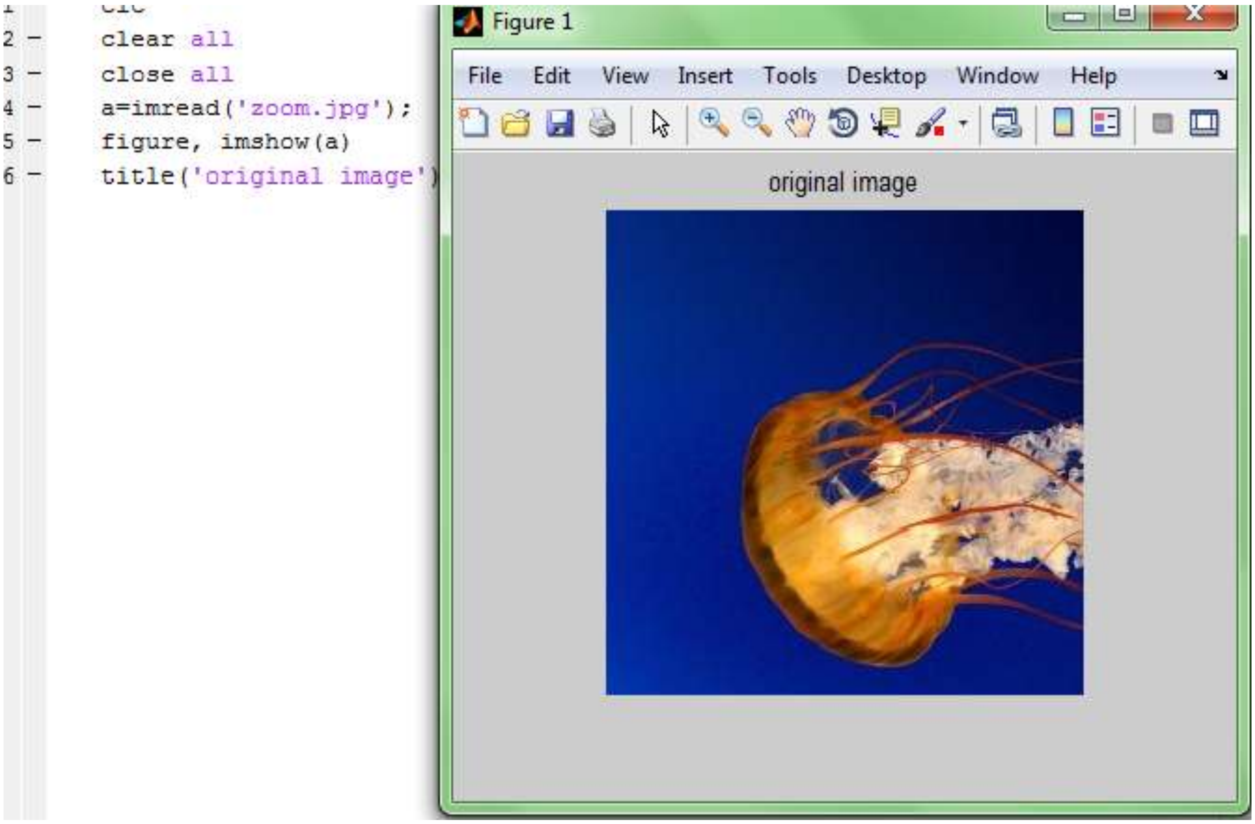


Fig4.4 Layout of Original Image

Step2: In second step we will convert original image "I" into a matrix form that is generated by MATLAB command such as

a=imread ('zoom.jpg')

Here "I" is "zoom.jpg" and in this mat lab command ***imread*** is a command to classify an image matrix. The image name is written in inverted commas with extension like that'zoom.jpg'. The image matrix of image I is stored in a identifier 'a'.

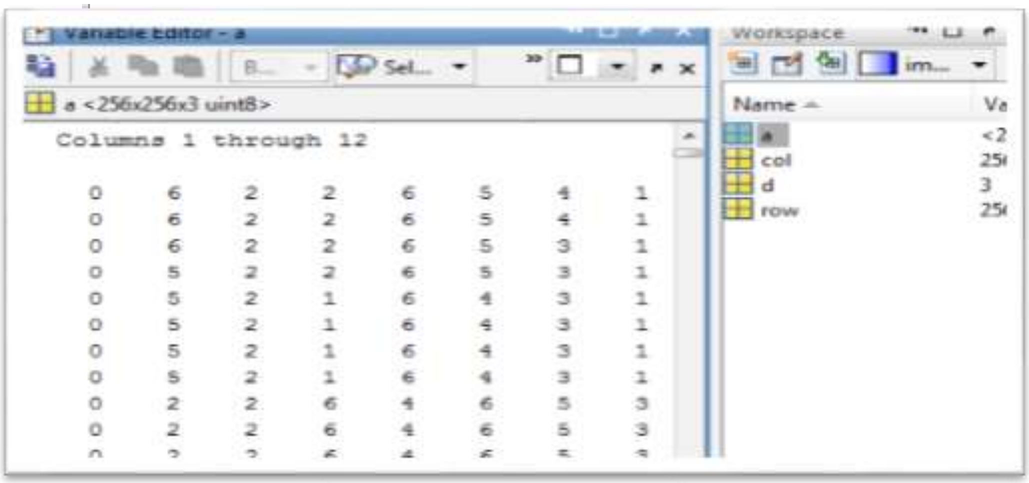


Fig4.5 Layout of rows and columns matrix

Step3: We will use command size **to** identify their size through MATLAB

(row col d)=size (a).

Size command is used to find out size of given image and output of command is stored in row col d and size is like that 3*3 or % 3 factor etc.

Step 4: After the size command we will enter the zooming number or scale factor through *input* command.

scale= input (‘enter zooming number’)

This command is used to enter zooming number and store in scale

Step 5: Now we will Insert blank pixels according to zooming number by *zeros* command.

zr =scale*row;

zc=scale*col;

This command is used to generate blank pixel according to the situation like that starting from row and column up to scale or zooming factor

Step 6: By using bilinear interpolation function first two unknown values in horizontal

direction are calculated and then second we will find interpolated value with the help of pre calculated unknown values.

Step 7: We Repeated a preceding step till whole image does not covered.

So we can also define the neighboring 4 pixel as

BL=a(x1,y1,:)

TL=a(x1,y2,:)

BR=a(x2,y1,:)

TR=a(x2,y2,:)

That is Bottom Left point, top left point, bottom Right point and Top right point.

4.4 PROCEDURE FOR ZOOMED IMAGE THROUGH MATLAB STEPS-

1. First of all we will Open MATLAB Software.

2. We will find the editor window.

   File >> New >> Script

3.We will write Down the Program in Editor Window.

```
clc
clear all
close all
a=imread('zoom.jpg');       %import image"y.jpg"
figure, imshow(a)
title('original image')
[row col d] = size(a);  %3 dimentional array
scale=.9;                 %scaleing factor
zr=scale*row;
zc=scale*col;

for i=1:zr

    x=i/scale;

    x1=floor(x);
    x2=ceil(x);
    if x1==0
        x1=1;
    end
    xint=rem(x,1);

for j=1:zc

        y=j/scale;

        y1=floor(y);
        y2=ceil(y);
        if y1==0
            y1=1;
```

Fig4.6 Layout of Editor Window

4. After completion the program, click the RUN button.

5. A new window is opened with the columns and Rows matrix, shown in Fig.4.4

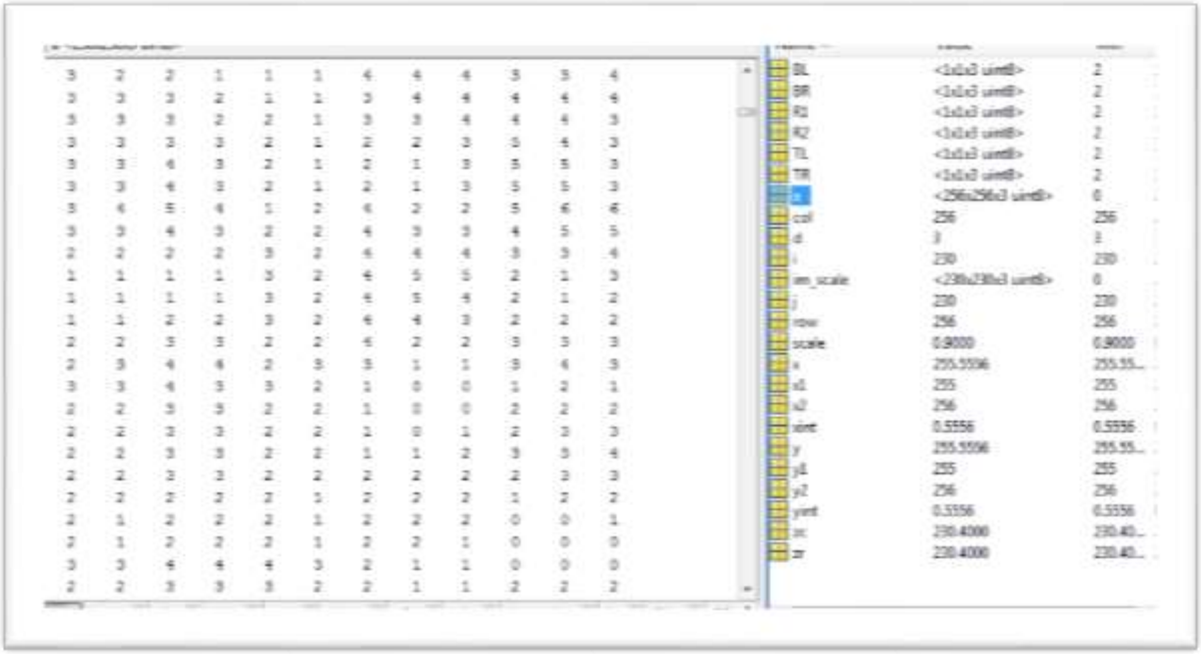


Fig.4.7 Layout of MATLAB to Calculation Window

6.Original image with MATLAB as shown in fig 4.5.

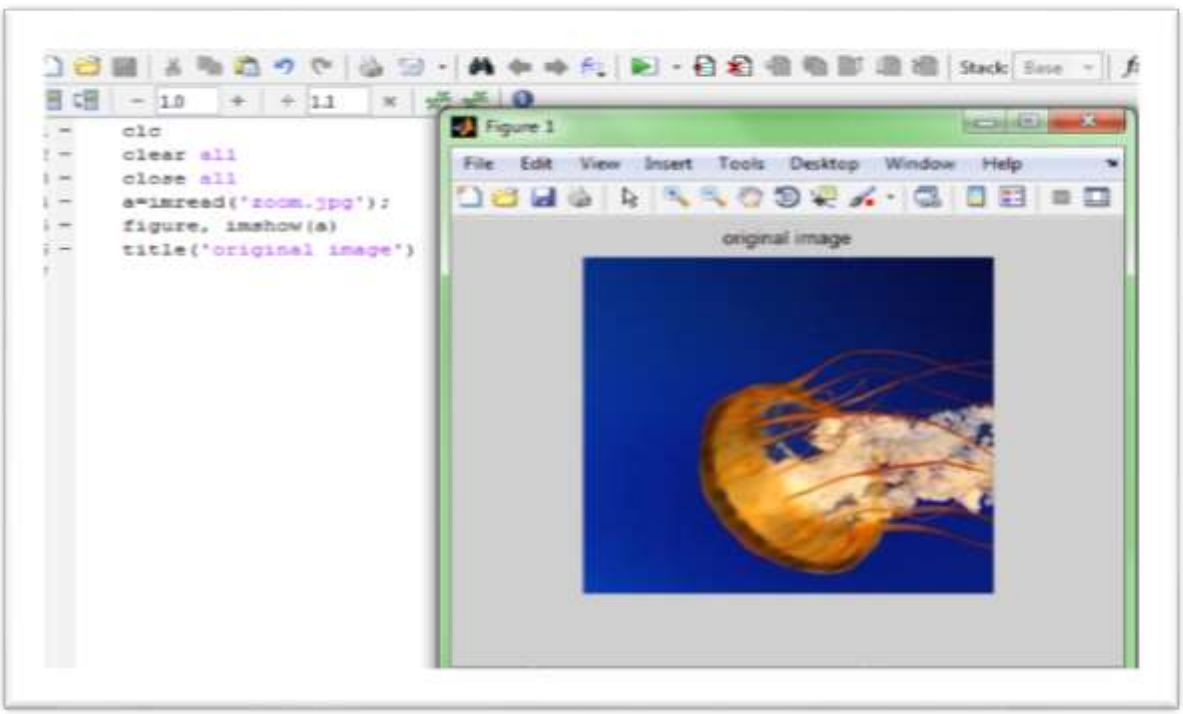


Fig.4.8 Layout of Original Image

7. Zoomed Image (2*X) is shown in fig4.6.

Fig.4.9 Layout of Zoomed Image

8. Find PSNR between original image and zoomed image by using following code.

```
title( 'zoomed image' )
% finds MSE and PSNR
a(256,:) = [];
a(:,256) = [];
[c5,c6] = size(a)
e=[];
for i = 1:c5
for j = 1:c6
end
end
MSE = sum(sum((im_scale(i,j)-a(i,j))^2))/(c5*c6);
PSNR = 10*log10(256*256/MSE);
```

psnr1.m

Fig.4.10 Code for the calculation of MSE & PSNR

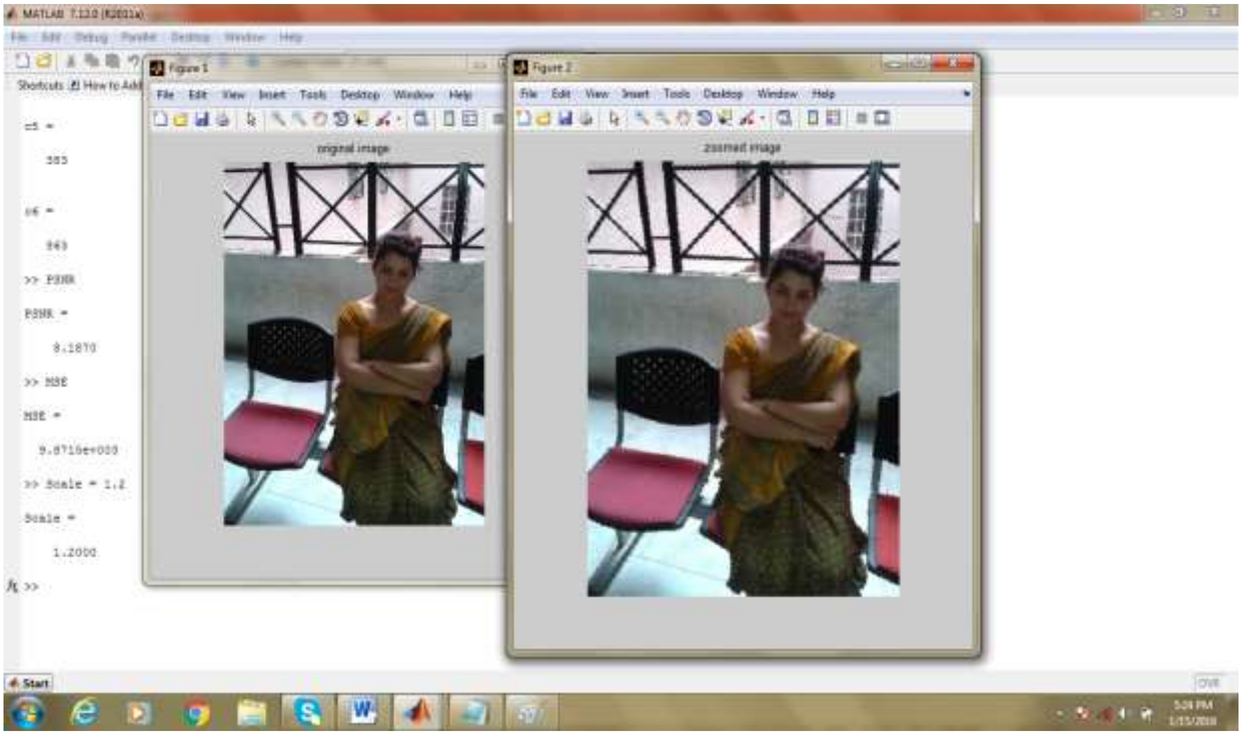


Fig 4.11 Layout of PSNR value of Image

4.5 Bilinear Interpolation (Row and column expansion) method:

The coolest method to do this interpolation is to find the average value between two pixels. After that we used that average value as the pixel value between those two pixels. This can be applied and completed for the rows first suppose original image is shown in the form of matrix below:-

Matrix for Original image

$$\begin{bmatrix} 8 & 4 & 8 \\ 4 & 8 & 4 \\ 8 & 2 & 8 \end{bmatrix}$$

Now after expanding this image by row:-

8 and 4 is our first two pixels in first row and its average value is ,(8+4)/2 =6 ,So now we have to insert this value between those two pixels 8 and 4. This step is done for every pixel in every pair of row, and next will take its result.

Image with Row expansion

$$\begin{bmatrix} 8 & 6 & 4 & 6 & 8 \\ 4 & 6 & 8 & 6 & 4 \\ 8 & 5 & 2 & 5 & 8 \end{bmatrix}$$

After the expansion by row wise next step is done by column expansion in the same way.

For example we are calculating average between each two pixel in the same column such as (6+5) /2 =5.5 or (6+6)/2=6, for 2st column .**New** image with Row and Column wise expansion is shown :-

Matrix for Image with Row and column Expansion

$$\begin{bmatrix} 8 & 6 & 4 & 6 & 8 \\ 6 & 6 & 6 & 6 & 6 \\ 4 & 6 & 8 & 6 & 4 \\ 6 & 5.5 & 5 & 5.5 & 6 \\ 8 & 5 & 2 & 5 & 8 \end{bmatrix}$$

By using this method we can enlarge an original image of N*N sized to new size image of (2n-1)*(2n-1) and we can repeat this algorithm as desired.

Table (1): Results of zooming by using purposed method

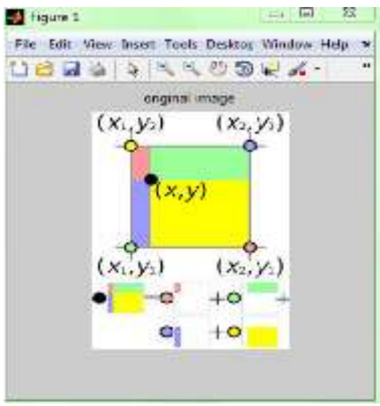
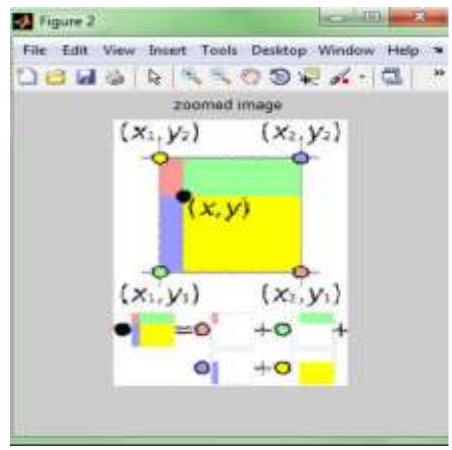
Images name	Original images	Zoomed images (Bilinear interpolation method)
Image 00		
Image 01		

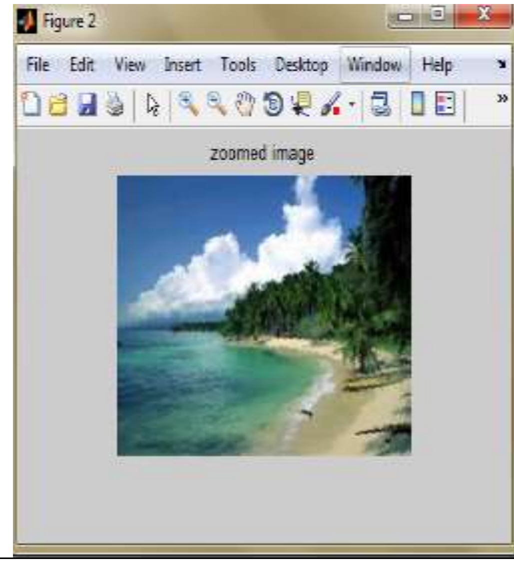
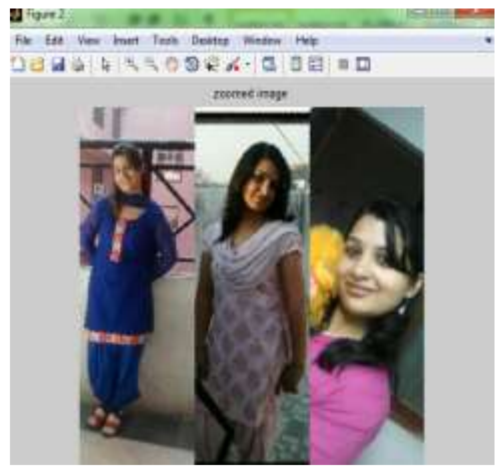
Image 02		
Image 03		

Table (2): illustrate results of image difference measures

(PSNR & MSE)

Image Method	PSNR	MSE
Image 1	15.0901	2.0141e+003
Image 2	14.7598	2.1732e+003
Image 3	21.3961	1.9749e+003
Image 4	10.6840	5.5209e+03

Table 2. Image Qualities of the Enlarged Color Images by the Purposed Technique for different scales

Image	**Scale = 1.2**	**Scale= 1.5**	**Scale = 2**
Image01	PSNR = 35.9812	PSNR = 26.2237	PSNR =15.2133
Image 02	PSNR = 29.1089	PSNR = 22.1564	PSNR = 14
Image 03	PSNR = 27.1087	PSNR = 25.1564	PSNR = 21.6758

Chapter -5

CONCLUSION & FUTURE WORK

5.1 Conclusion

A method was successfully implemented. We perform this interpolation method by MATLAB successfully.

In this thesis work, during our research, we have projected an image zooming algorithm i.e. based on Bilinear Interpolation techniques. We have compared our purposed algorithm with many existing interpolation algorithm on the base of visual and quantitative measurements.

From the experimental result we found that the *PSNR* of proposed algorithm is higher as compared to other interpolation methods, which give the conclusion about quality of resultant image of proposed algorithm is better than the other interpolation methods.

Visual inspection is also necessary for result measurement. When the visual results shown in Figure 4.3 and Figure 4.4 are analyzed, the proposed visual results are better than existing interpolation methods. In this proposed algorithm, artifacts in images formed are less as compared to the other interpolation methods. Basically, the proposed algorithm focuses on edges existing in the image and works on minimizing the artifacts.

From all the results it is concluded that proposed algorithm delivers better results both visually and quantitatively.

5.2 Future Work of Research

The future work of our interpolation algorithm would comprise the upgrading development of the proposed algorithm for the images and also advance its processing speed. The main mass factors we used in the proposed algorithm can be joint with other current existing algorithms and the results can be enhanced visually as well as quantitatively.

Abbreviations

AEE	Adaptive Edge Enhancement
HR	High-Resolution
LR	Low-Resolution
MSE	Mean Squared Error
PSNR	Peak Signal to Noise Ratio
TH	Threshold value
Wt	Weight
dpi	dot per inch
ppi	pixel per inch

RESULTS:-

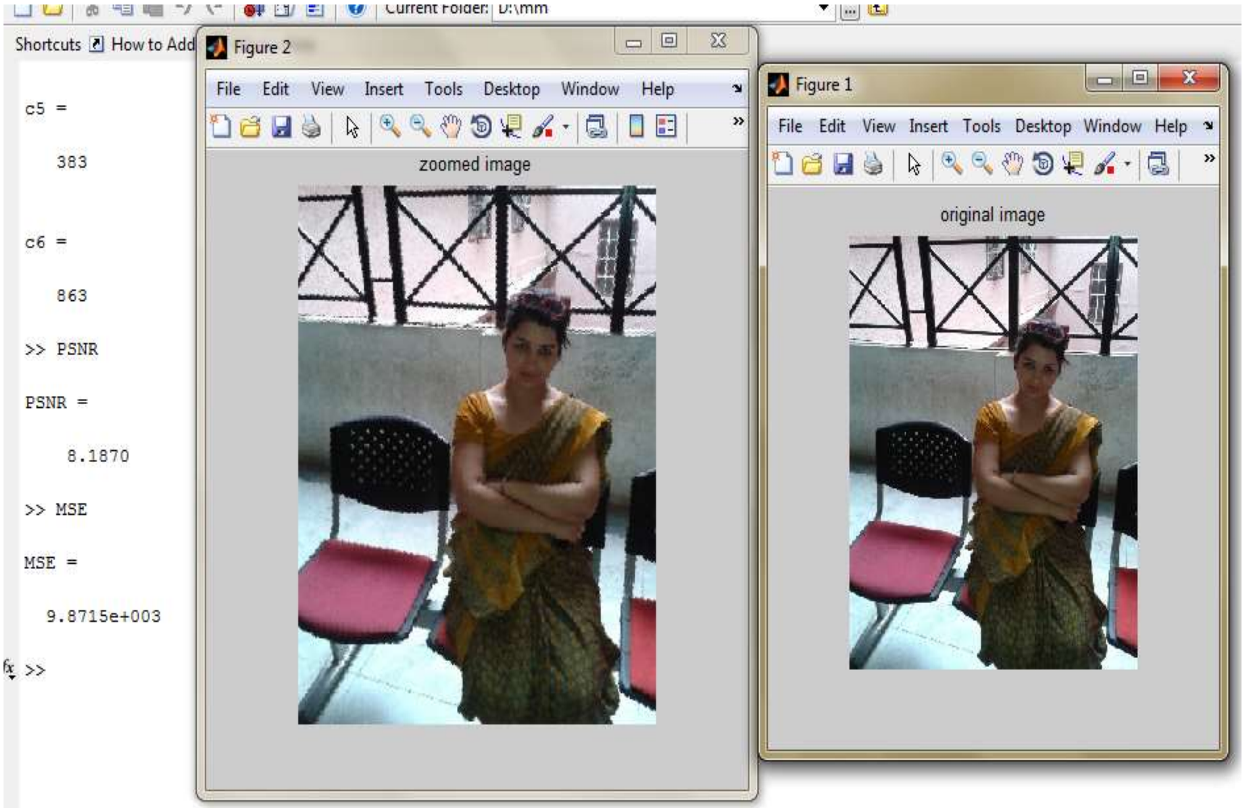


IMAGE 1

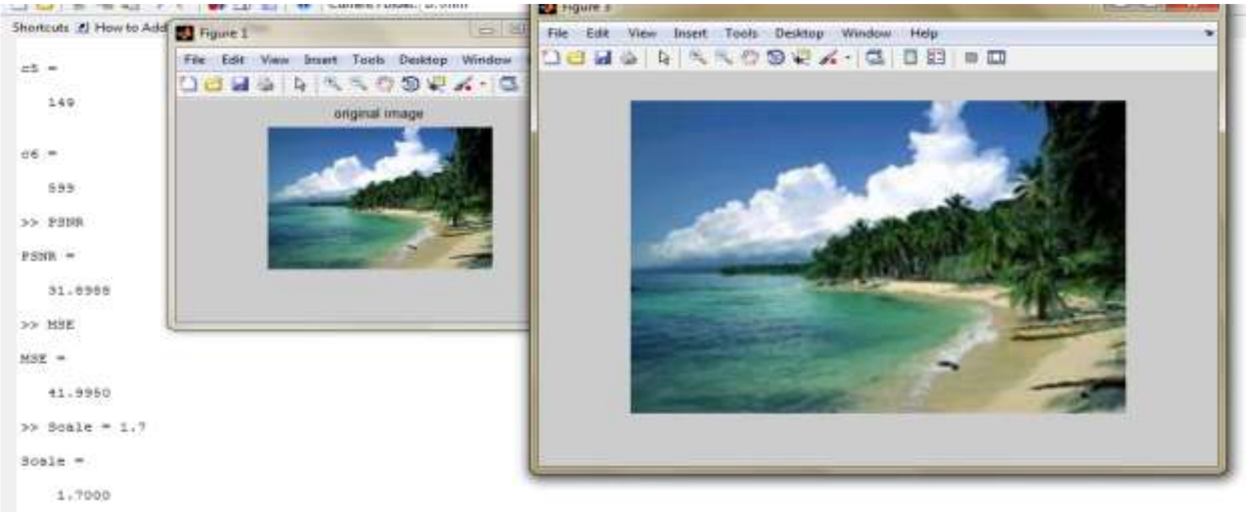


IMAGE 2

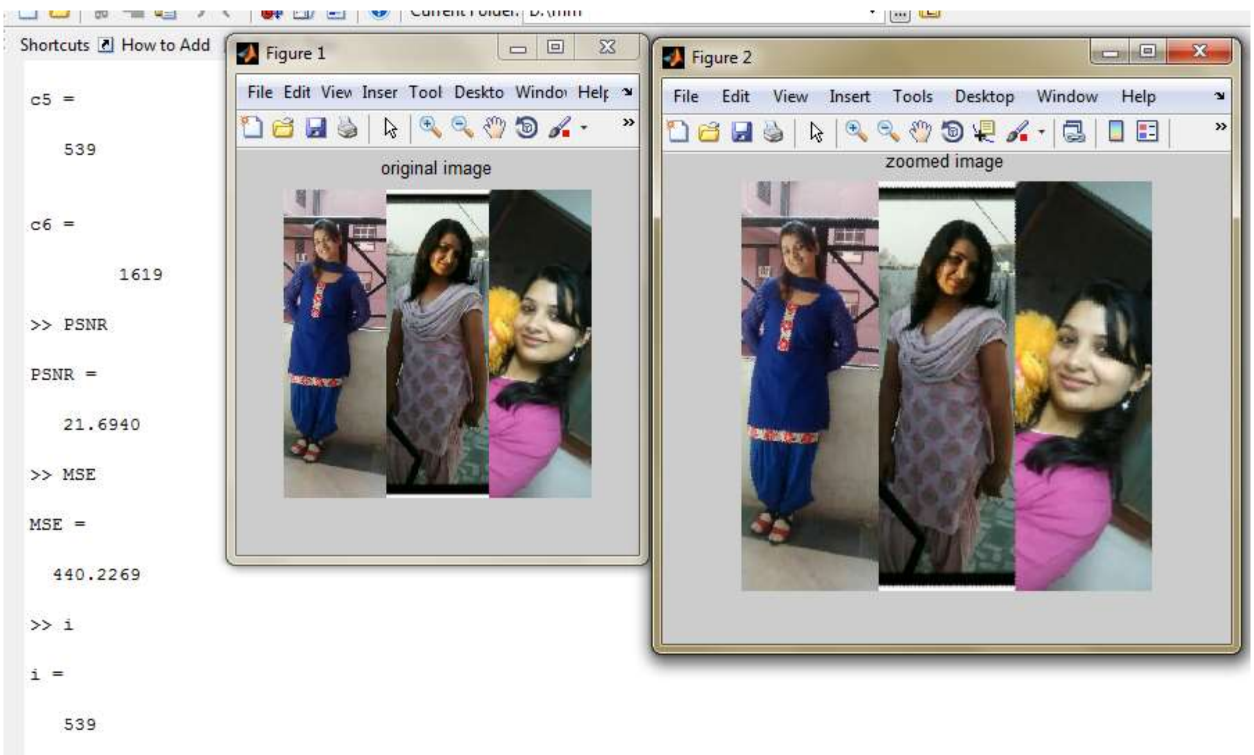


IMAGE 3

REFERENCES

[1] N. Nowrozian, H. Hassanpour, "Image Zooming using Non-linear Partial Differential Equation", IJE TRANSACTIONS, Basics Vol. 27, No. 1, pp.15-28 , January 2014.

[2] Ankit Prajapati, Sapan Naik, Sheetal Mehta, "Evaluation of Different Image Interpolation Algorithms", International Journal of Computer Applications, 0975 – 8887, Volume 58– No.12, November 2012.

[3] V. Kavitha, C. Mythili, "Efficient Technique for Color Image Noise Reduction", The Research bulletin Of Jordan, ACM, vol. 2, no.3, pp. 41-44, 2011.

[4] Lung-Jen Wang, Wen-Shyong Hsieh, Trieu-Kien Truong, Irving S. Reed, and T. C. Cheng*,'A Fast Efficient Computation of Cubic-Spline Interpolation in Image Codec'*

[5] R. Jansi, Asnath Victy Phamila, and R. Amutha, "Color Image Interpolation using Optimal Edge Detector", International Journal of Innovation and Applied Studies, ISSN 2028-9324 Vol. 3 No. 3, pp. 813-819, July 2013.

[6] Chandan Singh, 'Interpolation Methods Image Zooming', Proceeding of the National Conference FACM Thapar University, pp-29-34, March 2005.

[7] Chandan Singh, ′Interpolation Methods Image Zooming′, *Proceeding of the National Conference FACM Thapar University*, pp-29-34, March 2005.

[8] Zhang Min, Wang Jiechao, LI Zhiwei and LI Yonghua , ′An Adaptive Image Zooming Method with Edge Enhancement′, *3rd International Conference on Advanced Computer Theory and Engineering (ICACTE),* pp-608-611, 2010.

[9] Zhou Dengwen and Shen Xiaoliu, ′ An Effective Color Image Interpolation Algorithm′ ,4th *International Congress on Image and Signal Processing,* pp-984-988, 2011.

[11] Chen M.J., Huang C.H., Lee W.L., "A fast edge-oriented algorithm for image Interpolation", Image and Vision Computing, ELSEVIER, 23(9) 791-798, 2005.

[12] Pooja Kaushik and Yuvraj Sharma, "Comparison of Different Image Enhancement Techniques Based Upon Psnr & Mse", International Journal of Applied Engineering Research, ISSN 0973- 4562, Vol.7 No.11 (2012).

[13] Póth Miklós, "IMAGE INTERPOLATION TECHNIQUES", Marka Oreškovića 16 , 24000 Subotica, Serbia and Montenegro,2004.

[14] Rukundo Olivier, Cao Hanqiang, "Nearest Neighbor Value Interpolation", IJACSA, Vol. 3, No.4, pp.25-30, 2012.

[15] Ranjeet Roy, Maninder Pal and Tarun Gulati, "Zooming Digital Images using Interpolation Techniques", *IJAIEM*, ISSN 2319 – 4847, Volume 2, Issue 4, April 2013.

[16] Assist. Lect. Alhan Anwer Yunis Assist. Lect. Eman H. Abdurrahman, " Comparison Among Some Image Zooming Methods", College of Basic Education Researchers Journal Vol. (12), No.(3),pp. 761-774, 2013.

[17] Sudhir Sharma, Asst. Prof. Robin Walia, "Zooming Digital Images using Modal Interpolation", International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 2, Issue 5, ISSN 2319 – 4847, pp.305-310, May 2013.

[18] George Walberg, "CUBIC SPLINE INTERPOLATION: A REVIEW*"*, Technical Report, CUCS-389-88, September 1988.

[19] S. Battiato, G. Gallo, F. Stanco presents A locally adaptive zooming algorithm for digital

Images.

[20] Yu-Chen Hu, Bing-Hwang Su, Wu-Lin Chen and Wan-Yu Lu presents, ‘Image Zooming for Indexed Color Images Based on Bilinear Interpolation’