

Adaptive Technique for Image Zooming Based on Image Processing Technique

Chitra Arora
Dept. of CSE
MEC, Bikaner

chitraarora9483@gmail.com

Dr. Amit Sanghi
Dept. of CSE
MEC, Bikaner

dr.amitsanghi@gmail.com

Sunita Chaudhary
Dept. of CS & IT
Jagannath University, Jaipur
er.sunita03@gmail.com

Dr. Meenu Dave
Dept. of CS & IT
Jagannath University, Jaipur
meenu.s.dave@gmail.com

Abstract:- Due to the abilities of preserving sharp edges and detail, in this long essay sort of study matter interpolation schemes are considered. For the purpose of image zooming Cubic spline algorithm is used. With it analization of local structure of image and least time consuming near optimal re-sampling function would be there to preserve contrast and edge location. Into homogeneous areas this image is dynamically segmented, preserving edges is main focus here. In this algorithm Blurring and jaggng problem is reduced.

To compare existing algorithm with cubic spline by the help of algorithm method real world image is used. To arrive at conclusion that the cubic spline interpolation algorithm is not inferior to the existing algorithm, images are compared by two ways namely MSE and PSNR.

Keywords: Pixel Replication, Curve Fitting, Bilinear Interpolation, Bicubic Intertpolation, Cubic Spline Interpolation, Image Zooming, Digital Image Processing, Interpolation

1. Introduction

Digital images are more important in daily life and research and technology. The digital image consist a fixed no of row and column of pixels. Pixel is the smallest element in an image. So it is called picture element. Digital images are electronic representations of images that are stored on a computer.

Interpolation is the process by which small image is made larger. Interpolation is the method of enlarging the low resolution image to high resolution.

Interpolation has been used in several image processing application such as facial reconstruction, multiple description coding and super resolution.

Cubic spline interpolation is a fast, efficient and stable technique of function interpolation. T. The interpolation interval is divided into small subintervals. This each interval is interpolated by using the third degree polynomial. The idea of cubic spline interpolation was developed to analyze the real world numerical data

2. Adaptive And Non-Adaptive Interpolation Algorithm

Adaptive interpolation algorithm and Non adaptive interpolation algorithm. Adaptive algorithm depending on what they are interpolating (sharp edges v/s smooth texture) and Non adaptive technique treat all pixel equally. on adaptive algorithm-Depending on their complexity these use adjacent pixels. The more adjacent pixel they include the more accurate they can become but this comes at the expense of longer processing time. On adaptive algorithm

used for distort and resize a photo. Adaptive algorithms-It includes many proprietary algorithms in licensed software such as a image, genuine fractals, and photo zoom pro and others. Adaptive algorithm is primarily designed to maximize artifact free detail in enlarged photo so this algorithm used to distort and rotate an image.

3. Categorization of Image Interpolation

Basically, image interpolation techniques are divided into 3 broad categories:

3.1 Linear Techniques - Linear interpolation is a method of curve fitting. Linear techniques using linear polynomials [10]. The concept of linear interpolation relies on the assumption that the rate of change between the known values is constant.

The simplest interpolation is the nearest neighbor and "sinc" method. Nearest neighbor is related to replication of source pixels, but this technique introduces blocking effect. In blocking effect, a full digital image is partitioned into small square blocks. It appears as discontinuity along the block boundaries. Bilinear interpolation is effective for minimizing block boundary and preserve edges. Moreover, to extract the edge information of the image, fuzzy concept is used.

3.2 Nonlinear Techniques: Nonlinear interpolation is used to develop a smooth curve between two or more points. This curve is called spline. Interpolation method relies on constructing a polynomial of low degree between each pair of known data points. If a first degree polynomial is used, it

is called linear interpolation. For second and third degree polynomials, it is called quadratic and cubic splines respectively.

. The General Formula of (n-1)th order polynomial.

$$f(x) = a_0 + a_1x + a_2x^2 + \dots + a_{(n-1)} x^{(n-1)}$$

4. Quality Assessment

To compare the performance of the several algorithm and measure the quality, we will take a test image was zoomed out to half of the original size and then the shrunken image was expanded to its original size by using many algorithm. At last the enlarged image quality was compared from two aspects: Subjective and Quantitative.

4.1 Subjective - Subjective quality is a characteristic of quality assessment. It is concerned with how video is perceived by a viewer. Image is used to be watch by people. It is more suitable to evaluate zoomed image quality with subjective methods.

4.2 Quantitative

4.2.1 Mean Absolute Error (MAE) - The Mean Absolute error is error of absolute value of the difference between source image and Zoomed image. Lower value of MAE indicates higher accuracy in image. The mean absolute error is calculated by:

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

4.2.2 Mean Square Error (MSE) - MSE calculates the standard deviation of error signal .It should be lower value for high quality image. The mean Square error is calculated by:

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

m, n –Coordinate points

I – Source image

K –Zoomed image

4.2.3 Peak Signal to Noise Ratio [PSNR]-The peak signal to noise ratio is the ratio of maximum power of signal and the power of noise signal of its representation. This ratio is used as a quality measurement between source and zooming image. Many interpolation techniques have been developed to increase the quality of this task .

psnr value is usually expressed in terms of the decibel(db).

The PSNR is expressed in terms of

$$PSNR = 10. \log_{10} \frac{MAX_I^2}{MSE}$$

$$PSNR = 10. \log_{10} \left(\frac{MAX_I}{\sqrt{MSE}} \right)^2$$

$$PSNR = 20. \log_{10} \left(\frac{MAX_I}{\sqrt{MSE}} \right)$$

Where

MAX_I =maximum pixel value, (2^B -1)

B= bits per samples

MSE = means square error

5. Pixel Replication Interpolation

Pixel replication is simplest technique, this is used for zooming. It is also known as point shifting interpolation or NNI. NNI (nearest neighbor interpolation) selects the value of the nearest point to the specified input coordinates, and assigns that value at the empty location by copying the pixel value. It should be noted that this scheme does not create a new value, it copies existing values.

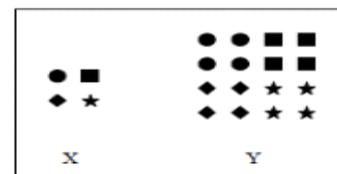
Divide the problem is divided into a number of sub-problems, the n-element sequence to be sorted into two subsequences of n/2 element.

Conquer the sub-problems by solving them recursively (if a sub-problem is small enough, just solving it in a straightforward manner. Sort the two subsequences recursively using merge sort).

Combine the solutions to the sub-problems into the solution for the original problem. Merge the two sorted subsequences to produce the sorted answer.

5.1 Extraction of Pixel Replication Interpolation

Pixel replication Interpolation is applicable when we want to enlarge an image by any integer number of times i.e. double, triple, quadruple etc. In this technique pixel value is repeated according to the zooming number.



Pixel Replication Working

The above shows pixel replication works. The X image is 2X magnified and in particular pattern hence we got the image Y.

5.2 Pseudo code of pixel replication

Step1: Input source image.

Step2: Convert source image into a matrix form. We used MATLAB command for matrix form.

```
A=imread ('pout.tif')
```

imread command is used for converting image into matrix form. Image matrix stored in identifier The image name is written in inverted commas with extension.

Step3: Identify their size through MATLAB command *size*.

```
C=size (A)
```

Size command is used to find out image size. The output of command is stored in C and size is 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: We used zero command for inserting pixel.

```
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 copy it at nearest blank position in row till then end of row similarly we will follow the same process for columns and Fill all the blanked pixel positions with their nearest value.

Advantage-This technique Main advantage is high processing speed.

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

6. Bilinear Interpolation Method:-

In bilinear interpolation considers the closest 2X2 neighborhood of known pixel surrounding unknown pixel. It then takes a weighted interpolated value. In this interpolation obtained smoother image compare to pixel replication.

6.1 Pseudo Code of Bilinear Interpolation:

Step1: Input source image.

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

```
A=imread ('pout.tif')
```

Here *imread* is a command to identify an image matrix. The image name is written in inverted commas with extension like that 'pout.tif'. The image matrix is store in a identifier A.

Step3: Identify their size through MATLAB command *size*.

```
C=size (A)
```

Size command is used to find out image size. The output of command is stored in C and size is 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: According to the bilinear interpolation, first of all we will calculate two unknown values in horizontal direction and secondly we will find interpolated value with the help of pre calculated values.

Step 7: Repeat previous step until whole image does not covered.

Advantage- Bilinear Interpolation algorithm provides better tradeoff between computational cost and picture quality.

Disadvantage- Interpolated image have blurredness problem. This problem was reduced by introducing bicubic interpolation.

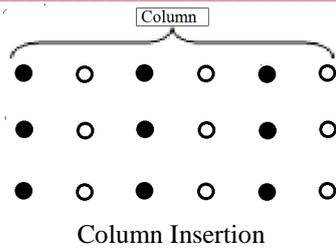
6.2 Bicubic Interpolation Method

Bicubic interpolation is an extension of cubic spline interpolation on a two dimensional regular grid. Bilinear interpolation, which only takes 4 pixels (2x2) into account, bicubic interpolation considers 16 pixels (4x4). Idea behind cubic spline interpolation is based on the engineer's tool used to draw smooth curves through a number of points. Cubic scheme determines the grey level from the weighted average of the 16 closest pixels to the specified input coordinates, and assigns that value to the output coordinates. The image is theoretically slightly sharper than that produced by bilinear interpolation and it does not have the disjointed appearance produced by pixel replication interpolation.

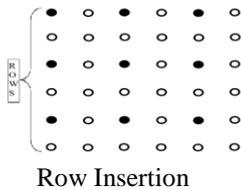
6.2.1 Pseudo Code of Bicubic Interpolation:

Step: 1 Input original image and convert into matrix form.

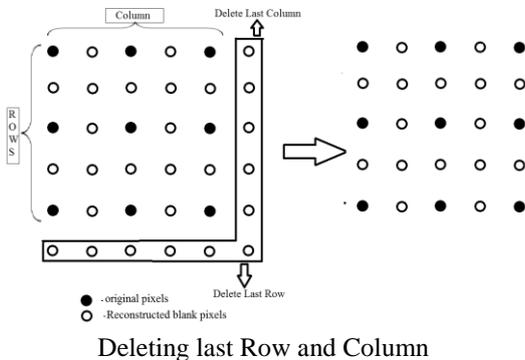
Step: 2 Insert new pixels according to zooming number in columns



Step: 3 Insert new pixels according to zooming number in rows



Step: 4 Delete last row and column



Step: 5 create a matrix corresponding by bicubic spline technique.

$$\begin{bmatrix} 6 & 0 & 0 & \dots & 0 & 0 & 0 \\ 1 & 4 & 1 & \dots & 0 & 0 & 0 \\ 0 & 1 & 4 & \dots & 0 & 0 & 0 \\ & & & \vdots & & & \\ 0 & 0 & 0 & \dots & 4 & 1 & 0 \\ 0 & 0 & 0 & \dots & 1 & 4 & 1 \\ 0 & 0 & 0 & \dots & 0 & 0 & 6 \end{bmatrix} \begin{bmatrix} M_2 \\ M_3 \\ M_4 \\ \vdots \\ M_{n-3} \\ M_{n-2} \\ M_{n-1} \end{bmatrix} = \frac{6}{h^2} \begin{bmatrix} y_1 - 2y_2 + y_3 \\ y_2 - 2y_3 + y_4 \\ y_3 - 2y_4 + y_5 \\ \vdots \\ y_{n-4} - 2y_{n-3} + y_{n-2} \\ y_{n-3} - 2y_{n-2} + y_{n-1} \\ y_{n-2} - 2y_{n-1} + y_n \end{bmatrix}$$

Step: 6 calculate the values of M in terms of y using matrix of cubic spline algorithm.

$$M_n = 2M_{n-1} - M_{n-2}$$

Step: 7 repeat all previous steps until whole image is not processed.

7. Cubic Spline Interpolation

A cubic spline is made up of pieces of cubic polynomials so cubic spline is piecewise curve [23]. A cubic spline is a spline constructed of piecewise third-order polynomials which pass through a set of control points. Cubic spline

interpolation is a very useful technique to interpolate between known data points due to its smooth and stable characteristics.

The main advantages of spline interpolation are its calculation simplicity and simplicity. Sets of linear equations which should be solved to construct splines are well-conditioned; therefore, the polynomial coefficients are calculated precisely.

- If the exact values of the first derivative in both boundaries are known, such spline is called *clamped spline*.
- If the value of the first (or second) derivative is unknown, we can set the so-called natural boundary conditions $S''(A)=0$, $S''(B)=0$. Thus, we get a natural spline.
- One more boundary condition which we can use when boundary derivatives are unknown is the "parabolically terminated spline". In this case, the boundary interval is represented as the second (instead of the third) degree polynomial (for inner intervals, third-degree polynomials are still used). In a number of cases this provides better accuracy than natural boundary conditions.
- We can also set periodic boundary conditions (this kind of conditions is used to model periodic functions).

7.2 Mathematical Analysis of Cubic Spline Interpolation

A cubic spline interpolation is given by

$$s(x) = a + bx + cx^2 + dx^3$$

Here four coefficient a, b, c and d need to be calculated.

Cubic spline should be conforming to the following points.

1. The piecewise function $S_i(x)$ will interpolate all data points.
2. $S_i(x)$ will be continuous on the interval $[x_1, x_n]$
3. $S_i'(x)$ will be continuous on the interval $[x_1, x_n]$
4. $S_i''(x)$ will be continuous on the interval $[x_1, x_n]$

Following the stipulations, we deduce the formulas for the coefficients as

The Fundamental concept is to fit a piecewise function of the form

$$S_i(x) = \begin{cases} S_1(x) & \text{if } x_1 \leq x < x_2 \\ S_2(x) & \text{if } x_2 \leq x < x_3 \\ \vdots & \vdots \\ S_{n-1}(x) & \text{if } x_{n-1} \leq x < x_n \end{cases}$$

Where $S_i(x)$ is a third degree polynomial.

$$s'_i(x_i) = 3a_i(x_i - x_i)^2 + 2b_i(x_i - x_i) + c_i$$

A Cubic Spline Third Degree Polynomial is defined by –

$$s'_i(x_i) = c_i$$

$$s_i(x) = a_i(x - x_i)^3 + b_i(x - x_i)^2 + c_i(x - x_i) + d_i$$

Now $s'_{i-1}(x_i) = 3a_{i-1}(x_i - x_{i-1})^2 + 2b_{i-1}(x_i - x_{i-1}) + c_{i-1}$

Where $i = 1, 2, 3, \dots, n - 1$

$$c_i = 3a_{i-1}(x_i - x_{i-1})^2 + 2b_{i-1}(x_i - x_{i-1}) + c_{i-1}$$

The first and second derivatives of this above equation—

$$s'_i(x) = 3a_i(x - x_i)^2 + 2b_i(x - x_i) + c_i$$

Letting $h = x_i - x_{i-1}$,

$$s''_i(x) = 6a_i(x - x_i) + 2b_i$$

So

$$c_i = 3a_{i-1}h^2 + 2b_{i-1}h + c_{i-1}$$

for $i = 1, 2, 3, \dots, n - 1$.

Since all data point will be interpolated by function $S(x)$, we can conclude that

From eq $s''_i(x) = 6a_i(x - x_i) + 2b_i$, so

$$S(x_i) = y_i$$

$$s''_i(x_i) = 6a_i(x_i - x_i) + 2b_i$$

$$s''_i(x_i) = 2b_i$$

for $i = 1, 2, \dots, n - 1$.

for $i = 1, 2, 3, \dots, n - 1$.

Since $x_i \in [x_i, x_{i+1}]$, $S(x_i) = s_i(x_i)$, equ. (4.3) can be produced as

since $s''_i(x_i)$ has to be continuous across the interval, $s''_i(x_i) = s''_{i+1}(x_i)$ for

$$y_i = s_i(x_i)$$

$i = 1, 2, 3, \dots, n - 1$

$$y_i = a_i(x_i - x_i)^3 + b_i(x_i - x_i)^2 + c_i(x_i - x_i) + d_i$$

$$s''_i(x_{i+1}) = 6a_i(x_{i+1} - x_i) + 2b_i$$

If $x = x_i$, then from above equation.

$$s''_{i+1}(x_{i+1}) = 6a_{i+1}(x_{i+1} - x_i) + 2b_{i+1}$$

$$y_i = a_i(x_i - x_i)^3 + b_i(x_i - x_i)^2 + c_i(x_i - x_i) + d_i$$

Letting $h = x_{i+1} - x_i$ and using conclusion from equ.

$$y_i = d_i$$

$$b_{i+1} = 6a_i h + 2b_i$$

For $i = 2, 3, 4, \dots, n$

Now $i = i - 1$

$$s_{i-1}(x_i) = a_{i-1}(x_i - x_{i-1})^3 + b_{i-1}(x_i - x_{i-1})^2 + c_{i-1}(x_i - x_{i-1}) + d_{i-1}$$

This equation can be simplified by the substituting M_i for $s''_i(x_i)$.

So $d_i = a_{i-1}(x_i - x_{i-1})^3 + b_{i-1}(x_i - x_{i-1})^2 + c_{i-1}(x_i - x_{i-1}) + d_{i-1}$

$$s''_i(x_i) = 2b_i$$

$$M_i = 2b_i$$

Suppose $h = x_i - x_{i-1}$

From eq.

$$b_i = M_i/2$$

So $d_i = a_{i-1}h^3 + b_{i-1}h^2 + c_{i-1}h + d_{i-1}$ for $i = 2, 3, \dots, n - 1$

$$2b_{i+1} = 6a_i h + 2b_i$$

$$6a_i h = 2b_{i+1} - 2b_i$$

Property – To make smooth curve, derivatives must be equals at the data points; that is,

$$s'_i(x_i) = s'_{i-1}(x_i)$$

$$a_i = \frac{2b_{i+1} - 2b_i}{6h}$$

According to the eq

$$a_i = M_{i+1} - M_i/6h$$

And c_i can be calculated as

$$d_{i+1} = a_i h^3 + b_i h^2 + c_i h + d_i$$

$$c_i h = -a_i h^3 - b_i h^2 - d_i + d_{i+1}$$

$$c_i = \frac{-a_i h^3 - b_i h^2 - d_i + d_{i+1}}{h}$$

$$c_i = \frac{-a_i h^3 - b_i h^2}{h} - \frac{d_i - d_{i+1}}{h}$$

$$c_i = -a_i h^2 - b_i h - \frac{d_i - d_{i+1}}{h}$$

$$c_i = -\left(\frac{M_{i+1} - M_i}{6h} h^2 + \frac{M_i}{2} h\right) - \frac{y_i - y_{i+1}}{h}$$

$$c_i = -\left(\frac{M_{i+1} - M_i}{6} h + \frac{3M_i}{6} h\right) - \frac{y_i - y_{i+1}}{h}$$

$$c_i = -\left(\frac{M_{i+1} + 2M_i}{6}\right) h - \frac{y_i - y_{i+1}}{h}$$

$$c_i = \frac{y_{i+1} - y_i}{h} - \left(\frac{M_{i+1} + 2M_i}{6}\right) h$$

$$a_i = \frac{y_{i+1} - y_i}{6h}$$

$$b_i = \frac{M_i}{2}$$

$c_i =$

$$\frac{y_{i+1} - y_i}{h} - \left(\frac{M_{i+1} + 2M_i}{6}\right) h \quad d_i = y_i$$

To find out the matrix, we use eq.

$$c_i = 3a_{i-1} h^2 + 2b_{i-1} h + c_{i-1}$$

$$c_{i+1} = 3a_i h^2 + 2b_i h + c_i$$

Put the value of a_i, b_i, c_i , we have

$$\begin{aligned} & 3\left(\frac{M_{i+1} - M_i}{6h}\right) h^2 + 2\left(\frac{M_i}{2}\right) h + \frac{y_{i+1} - y_i}{h} \\ & - \left(\frac{M_{i+1} + 2M_i}{6}\right) h \\ & = \frac{y_{i+2} - y_{i+1}}{h} - \left(\frac{M_{i+2} + 2M_{i+1}}{6}\right) h \end{aligned}$$

$$\begin{aligned} & 3\left(\frac{M_{i+1} - M_i}{6h}\right) h^2 + 2\left(\frac{M_i}{2}\right) h - \left(\frac{M_{i+1} + 2M_i}{6}\right) h \\ & + \left(\frac{M_{i+2} + 2M_{i+1}}{6}\right) h \end{aligned}$$

$$\begin{aligned} & = \frac{y_{i+2} - y_{i+1}}{h} - \frac{y_{i+1} - y_i}{h} \\ & h \left[3\left(\frac{M_{i+1} - M_i}{6}\right) + 6\left(\frac{M_i}{6}\right) - \left(\frac{M_{i+1} + 2M_i}{6}\right) \right. \\ & \quad \left. + \left(\frac{M_{i+2} + 2M_{i+1}}{6}\right) \right] \\ & = \frac{1}{h} (y_{i+2} - y_{i+1} - y_{i+1} + y_i) \end{aligned}$$

$$\begin{aligned} & \frac{h}{6} [3(M_{i+1} - M_i) + (M_i) - (M_{i+1} + 2M_i) \\ & \quad + (M_{i+2} + 2M_{i+1})] \\ & = \frac{1}{h} (y_{i+2} - 2y_{i+1} + y_i) \end{aligned}$$

$$\begin{aligned} & (3M_{i+1} - 3M_i + 6M_i - M_{i+1} - 2M_i + M_{i+2} + 2M_{i+1}) \\ & = \frac{6}{h} \frac{1}{h} (y_{i+2} - 2y_{i+1} + y_i) \end{aligned}$$

$$(M_i + 4M_{i+1} + M_{i+2}) = \frac{6}{h^2} (y_{i+2} - 2y_{i+1} + y_i)$$

for $i = 1, 2, 3, \dots, n-1$

Which lead to the matrix equation?

$$\begin{bmatrix} 1 & 4 & 1 & 0 & \dots & 0 & 0 & 0 & 0 \\ 0 & 1 & 4 & 1 & \dots & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 4 & \dots & 0 & 0 & 0 & 0 \\ & & & \vdots & & & & & \\ 0 & 0 & 0 & 0 & \dots & 4 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \dots & 1 & 4 & 1 & 0 \\ 0 & 0 & 0 & 0 & \dots & 0 & 1 & 4 & 1 \end{bmatrix} \begin{bmatrix} M_1 \\ M_2 \\ M_3 \\ M_4 \\ \vdots \\ M_{n-3} \\ M_{n-2} \\ M_{n-1} \\ M_n \end{bmatrix}$$

$$= \frac{6}{h^2} \begin{bmatrix} y_1 - 2y_2 + y_3 \\ y_2 - 2y_3 + y_4 \\ y_3 - 2y_4 + y_5 \\ \vdots \\ y_{n-4} - 2y_{n-3} + y_{n-2} \\ y_{n-3} - 2y_{n-2} + y_{n-1} \\ y_{n-2} - 2y_{n-1} + y_n \end{bmatrix}$$

It assigns M_1 to be $2M_2 - M_3$ and M_n to be $2M_{n-1} - M_{n-2}$. This causes the curve to degrade to single cubic.

$$\begin{bmatrix} 6 & 0 & 0 & \dots & 0 & 0 & 0 \\ 1 & 4 & 1 & \dots & 0 & 0 & 0 \\ 0 & 1 & 4 & \dots & 0 & 0 & 0 \\ & & & \vdots & & & \\ 0 & 0 & 0 & \dots & 4 & 1 & 0 \\ 0 & 0 & 0 & \dots & 1 & 4 & 1 \\ 0 & 0 & 0 & \dots & 0 & 0 & 6 \end{bmatrix} \begin{bmatrix} M_2 \\ M_3 \\ M_4 \\ \vdots \\ M_{n-3} \\ M_{n-2} \\ M_{n-1} \end{bmatrix} = \frac{6}{h^2} \begin{bmatrix} y_1 - 2y_2 + y_3 \\ y_2 - 2y_3 + y_4 \\ y_3 - 2y_4 + y_5 \\ \vdots \\ y_{n-4} - 2y_{n-3} + y_{n-2} \\ y_{n-3} - 2y_{n-2} + y_{n-1} \\ y_{n-2} - 2y_{n-1} + y_n \end{bmatrix}$$

This is final matrix for cubic spline interpolation technique. In this matrix, y_1 to y_n is related to original image coordinates and h is total image matrix size like that if an image has 3*3 sizes then h is 1.

Cubic spline is another method used for reconstructed image. A cubic spline function is particularly used for curve fitting between the existing points. Cubic spline is widely used to fit a smooth continuous function through discrete data. This function plays an important role in image processing and image interpolation. Cubic spline is useful in implementing high quality image zooming. If we joined several point in a common curve then we uses cubic spline technique because it uses derivatives at each end points.

8. Results

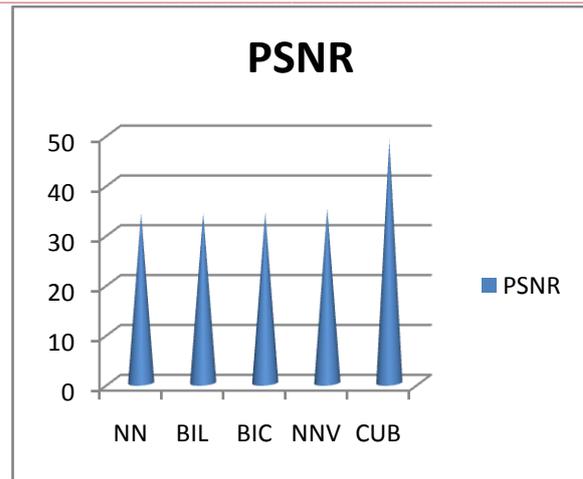
The results obtained conclude that the cubic spline interpolation algorithm presents a far better PSNR values. During the programming, various methods were kept in mind so as to obtain a lesser processing time. As this time depends on the processor of the machine, so this parameter cannot be compared with previously obtained results.

Experimental Result of image – PSNR and Processing Time

Image	MSE	PSNR(db)	Execution Time
Cameraman.tif	0.8670	48.7504	310.1507 Seconds Calculated on I5 processor with 4GB RAM

Comparison of different types of Interpolation Techniques

Interpolation Method	Nearest Neighbor (Base Paper)	Bilinear Interpolation (Base Paper)	Cubic Spline Interpolation (This work)	Execution Time (This work)
PSNR and Execution Time	34.0	34.1	48.7504	310.1507



Graphical Comparison of PSNR Value Using Different Method

9. Conclusion

We have proposed an adaptive image zooming algorithm based on cubic spline interpolation technique. The algorithm has been compared with other interpolation methods according to visual and quantitative measurements. The PSNR of proposed algorithm is higher and MSE is lower than the other interpolation methods, which conclude quality of resultant image of proposed algorithm is better than the other interpolation methods. We have implemented all algorithms and done the comparison. For commercial tools and applications which are not very important (use for commercial purpose only), non-adaptive algorithms are better to use while in application like medical, bioinformatics, satellite images, adaptive methods. A novel image zooming schemes for index coloured image is proposed. The bilinear interpolation technique is employed to enlarge the original image. The pixel grouping process is executed to the pixel in the enlarged image.

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