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Review Article

Study of Interpolation Techniques in Multimedia Communication System - A Review

Apurva Sinha†*

†Department of Electronics and Communication Engineering, SHIATS- Allahabad, UP. India

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Abstract

Interpolation is the process of enlargement of images which is used in modern era of communication system to get highly magnified best quality image. In this paper, different types of interpolation algorithms are presented, out of which Bicubic method exceeds all other methods as it eradicates the blurr and stair shaped edges, which were generated when all other interpolation algorithms were applied. Hence it is highly recommended in various Image processing based applications like Satellite Navigation, Television Broadcasting, Computer Graphics, Special Effects etc.

Keywords: *Interpolation, Nearest Neighbor, Bilinear, Bicubic*

1. Introduction

Interpolation or up-sampling of image means zooming an image or increasing the size of image. There are various applications which deal with the high picture quality. In those fields interpolation of an image is required to create a high resolution best quality picture. Due to limited channels bandwidth images are compressed at transmitter in order to send it via wireless atmosphere (or wired cables).When this compressed image is expanded at the receiver it causes loss of some particular details of images thus leading to the reception of poor quality image. Thus at receiver a technique is required which can not only expand the size of image but also preserve all the details that an image holds before it was transmitted. Thus interpolation plays an important role in reconstruction of image at receiver side as it not only creates a high resolution image but also retains the picture clarity and quality.

2. Methodology

Several interpolation techniques have been developed. The most commonly used methods are the Nearest Neighbor, Bilinear and Bicubic Interpolation techniques. Less common are the polynomial and Lagrange interpolation methods.

*Corresponding author: **Apurva Sinha**

The different Interpolation Methods are:

a. Nearest Neighbor

b. Bilinear

c. Bicubc

2.1 Nearest Neighbor

One of the simplest interpolation algorithms is Nearest-Neighbor interpolation. In order to up-sample or zoom an image Nearest Neighbor provides easiest way. Image enlargement requires two steps:- First is creation of new pixel locations and second is assignment of pixel values to those locations. This can be done by treating image as a matrix and creating new rows and columns by padding it with matrix having double the size of original image matrix and having only zero value so that every alternate rows or columns of resultant matrix contains zero as its pixel value. Next step is to assign the pixel value of the near most neighbor to the newly generated pixel. That is why this method of grey level assignment is called Nearest Neighbor Interpolation where each interpolated output pixel is assigned the value of the nearest sample point in the input image.

Let an image be there having pixels at x_1,y_1 & x_1,y_2 (they are the nearest neighbors).The pixel value of x_1,y_1 is known and x_1,y_2 has to be find out. If Nearest Neighbor technique is used it can be said that the value of pixel x_1,y_2 is equal to that of pixel x_1,y_1. This is depicted in the following figure1.

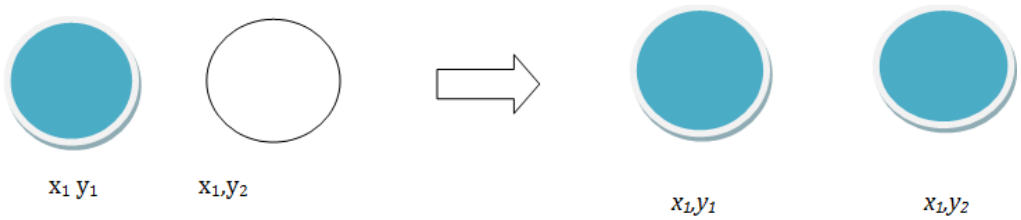

Figure 1

2.1.1 Algorithm of Nearest Neighbor Interpolation:-
The steps are as follows

1. Take the Color Image (RGB)
2. Add Salt and Pepper noise (or any other noise like Gaussian, Speckle etc) in it.
3. Decimate or Reduce the size of image by a factor of n (where n =2, 4, 8, 32……) pixels to convert it into a low resolution image.
4. Take another matrix, double the size of image matrix, containing only zeroes.
5. Pad this matrix with the reduced matrix so that size of reduced matrix increases to its original size in order to get every alternate rows and columns contain zero as its pixel value.
6. Copy the contents of jth column in j+1th column. Repeat the same procedure for row also.

Advantage

It is the simplest of all methods since it uses only 1 neighbour-hood pixel and hence it is least complex.

Disadvantage

The disadvantage of nearest neighbor is that when an image is enhanced many folds, it causes checkboard kind of image, hence it is not useful where high magnification is required.

2.2 Bilinear Interpolation

A slightly better way of assigning gray level assignments is Bilinear Interpolation which uses the four nearest neighbors of a point. The biggest drawback of nearest neighbor interpolation is that it cannot be used in high resolution zooming because it causes stair case edges. An interpolation technique that reduces the visual distortion caused by the fractional zoom calculation is the bilinear interpolation algorithm. It is performed in one direction first (row wise) then again in other direction (column wise). It uses four nearest neighbor of pixel whose value is to be determined. An image is selected and it is converted into matrix form. Another image of size 2m*2n is taken which contain zero elements. This matrix is padded with the matrix of image so that the resultan matrix contain zero elements in every alternate row and column.The weighted average of four pixels are calculated and the result is put into the newly generated pixel.

The final pixel value v(x,y) of x row and y column is calculated as follows:-

$$\mathbf{v(x, y) = a - b * v(x,y-1) + c - d * v(x, y+1)}$$

Where,

$$a = ((x+1) - x) / (x + 1)$$
$$b = (x - 1)$$
$$c = (x - (x - 1)) / (x + 1)$$
$$d = (x - 1)$$

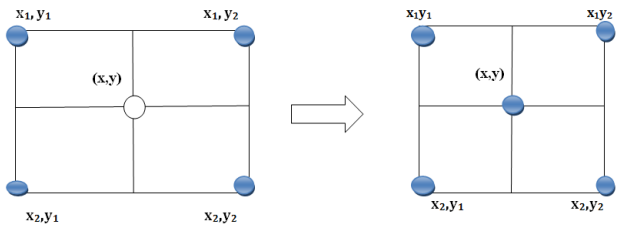

Fig.2 Bilinear Interpolation

Algorithm of Bilinear Interpolation

The steps are as follows

1. Take the Color (RGB) Image .
2. Add Salt and Pepper noise (or any other noise like Gaussian, Speckle etc) in it.
3. Decimate or reduce the size of image by a factor of n (where n = 2,4,8,32….) to convert it into a low resolution image.
4. Take another matrix which have double the size of image matrix containing only zeroes.
5. Pad this matrix with the reduced matrix so that size of reduced matrix increases to its original form so that every alternate rows and columns contain zero as its pixel value.
6. Take the mean of jth and j+2th column and put the result in j+1th column. Repeat the same procedure for row also.

Advantage

The advantage of this technique is that it produces a smoother image since it uses 4 neighborhood pixels hence it gives a more accurate image as compared to the nearest neighbor.

Disadvantage

Since it uses 4 pixels it is complex and at hgh resolution it does not gives satisfactory output because the image gets blurred.

2.3 Bicubic Interpolation

High order interpolation schemes take more pixels into account. Second order interpolation is called as Cubic Interpolation as it uses a neighborhood of 16 pixels. When speed is not an issue, Bicubic Interpolation is often chosen over Bilinear Interpolation or Nearest Neighbor in image enhancement. As compare to bilinear interpolation, which takes only 4 pixels (2x2) into account, Bicubic Interpolation considers 16 pixels (4x4). Images resample with bicubic interpolation are smoother and b;ur is not formed even when image is interpolated many times. It fits two polynomials to the 16 pixels of the transformed original matrix and the centre of the new image pixel .This technique is very effective and produces images that are very close to the original image

Algorithm of Bicubic Interpolation

The steps are as follows

1. Take the Color (RGB) Image.
2. Add Salt and Pepper noise (or any other noise like Gaussian, Speckle etc) in it.
3. Decimate or reduce the size of image by a factor of n (where n = 2, 4, 8, 16, 32….) pixels to convert it into a low resolution image.
4. Take another matrix double the size of image matrix containing only zeroes.
5. Pad this matrix with the reduced matrix so that size of reduced matrix increases to original form so that every alternate rows and columns contains zero as its pixel value.
6. Take the mean sixteen pixels near most to ith row and jth column and put the result in ith row and jth column

Advantage

The advantage of this resampling option is that it produces a smoothest image relative to the bilinear interpolation or nearest neighbor option.

Disadvantage

The disadvantage is that it is slower relative to the bilinear interpolation or nearest neighbor resampling and is complex as it involves more pixels into account.

2.4 Comparison among the three techniques

Features	Nearest Neighbor	Bilinear	Bicubic
Resampling	Fastest	Slower	Slowest
Resultant Image	Stair Type	Smother	Smoothest
Nearest Neighbors	1	4	16
Complexity	Simplest	Simple	Complex

Conclusion

This paper shows that Bicubic interpolation is much better than Nearest Neighbor Interpolation technique and Bilinear Interpolation technique, as it uses neighborhood of 16 pixels, hence it gives more approximate result. The blur and stair case edges caused by Bilinear and Nearest Neighbor Interpolation respectively if an image is interpolated two or more times two or more times interpolation is removed and much better image is obtained by Bicubic Interpolation algorithm

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Author

Apurva Sinha received her B.Tech Degree from department of Electronics And Communication Enineering from Mahatma Jyotiba Phule Rohilkhand University Engineering and Technology Bareilly, Uttar Pradesh in 2012.She has completed M.Tech from the Department of Electronics and Communication SHIATS, Allahabad. Her main research interest includes Communication System Engineering, Image Processing Systems etc.