Survey on Image Interpolation

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Abstract— Digital picture is a combination of pixels. Resolution is the feature of digital picture. Resolution defines detail of picture. Resolution is defined by no of pixels in a picture. High resolution picture contains more detail. Interpolation is done on picture to create a new interpolated picture. Interpolation is used for enhancement of picture. We have studied various interpolation methods to produce high quality pictures like Bilinear interpolation, bicubic interpolation and nearest neighbor interpolation methods. In nearest neighbor interpolation method, nearest neighbor value algorithm is used to create high resolution pictures. Bicubic interpolation is the better method to interpolate the picture. In it, interpolated picture has high quality and smooth. As compared to nearest neighbor and bilinear interpolation, it takes neighborhood of 16 pixels and is also used for scaling.

Keywords— Interpolation, nearest neighbor, resolution, bilinear, bicubic.

I. INTRODUCTION

Digital image is the binary representation of two dimensional pictures. Image may be of raster type or vector type. It depends upon resolution of image. The picture elements are combined to form a digital image. These picture elements are called pixels. Tonal value (black, white, grey or color) is assigned to each pixel. File formats are used by each image. There are various types of digital images. These are black and white images, colored images. Colored pixels are used to define color images. Color images are used RGB values. Pixels in different shades of gray are used to represent black and white images.

Digital image also requires one additional factor called resolution. No. of pixels in an image are used to identified resolution. For example: 2048*1536 images contain 3,145,728 pixels. Resolution of an image is expressed by dots-per-inch and pixels-per-inch. Width and height of picture are also identified resolution.

Interpolation is a technique to construct new points from known data points. Suppose when the formula is known for any given function, but it is difficult to evaluate efficiently. From given function, few data points can be used to create an interpolated based on function. Simple function gives estimation of complicated function that is called interpolation [6][9].

A. Needs of interpolation:
In many applications, resolution of picture plays an important role. Why we need resolution, it is described as follow:
- To improve the frequency of blurred pictures, many resolution enhancement techniques are used.
- Resolution is improved no. of pixels in a picture.
- It can be used to improve the quality of picture.
- If resolution is high, picture captures more detail.
- If resolution is low, picture has less information and looks like jagged and fuzzy.
- Resolution is used in printing to define actual size of pixels in pictures.

B. Challenges in image resolution enhancement:
It is quite difficult to improve the quality of picture and blurred pictures that are captured by satellite. These pictures have edges of poor quality. Some of new satellite picture resolution enhancement techniques are used.DWT provides sub bands of higher frequency. Picture resolution enhancement techniques are based on estimation of these sub bands. Using these methods, input picture can be divided into sub bands. By using inverse DWT, a new resolution enhanced picture can be produced using images of higher frequency sub bands and input picture of low resolution which have been estimated. Proposed high frequency bands are interpolated using median stage. Results of peak signal-to-noise ratio and root mean square error depict that this method is superb than other techniques.

II. LITERATURE SURVEY

The picture interpolation is done to create a new interpolated picture. Interpolation ratio describes the size of new constructed picture. Empty spaces in source picture are filled with appropriate pixel values. Some of Conventional methods have been described below and outcomes of these are as follow:

In [4], author described that in nearest neighbor method, nearest neighbor pixel values will fill in the empty spaces in given pictures. Nearest neighbor method gives better speed. In the other hand, bilinear method gives good computational

efficiency. In bilinear method, empty spaces in given picture will fill in with weighted values. Better picture quality and cost are provided by this method.

In [1], author proposed the simple and faster interpolation method that is nearest neighbor interpolation. It is not used due to problem of stair case edges. Bicubic is used in 3G graphics because of its better results. Blurry images are causes of nearest neighbor method. Bilinear interpolation method is better than the nearest neighbor method.

In [5], author proposed that demosaicing is a process to produce high resolution picture. According to neighboring colors, other colors have been estimated. Demosaicing is considered as theorical model. CCD array is not in centre in advanced cameras. Every pixel knows about its neighbors.

In [7], author described exponential B-Spline method that is simple and easy to calculate exponential B-Spline. In this paper, different interpolation methods nearest interpolation, cubic interpolation and bilinear interpolation methods are described in time and frequency domains. Cubic spline is better than other methods.

In [6], Zooming is difficult in low resolution pictures. For processing the CT scan pictures, ideal low pass filter is used for zooming. Nearest neighbor, bilinear, cubic B-spline interpolation methods are used for this purpose but cubic B-spline is better than others. All of these define in time and frequency domain. Pass band and low pass performance is described on basis of linear and logarithmic scale of frequency domain.

In [9], both of interpolation methods such as adaptive and non-adaptive methods is compared. Visuality of picture is better in adaptive techniques. But it consumes more time for computation.

In [8], this paper described a new approach to cubic spline interpolation method. This approach is based on various parameters. Quality of the reconstructed picture is improved using this algorithm. Optimal parametric algorithm is used to define optimal parameters of various pictures. This algorithm is also described the opportunity cost.

In paper [3], Median –filter based method is proposed. This method is simple and fast. To speed up the median filter process, this method calculates the median value of four neighboring pixels. This method has better performance than the bi cubic and bilinear filter methods.

In [2], low pass filter is used for resampling in order to achieve better picture quality. Performance of all interpolation methods is defined in pass and stop zone. Nearest neighbor interpolation has better performance in pass zone. High resolution cubic spline method provides better result than other methods.

III. METHODS OF INTERPOLATION

Interpolation is a technique to construct new data points from a known data points. Techniques of interpolation are described as follow:

A. Bilinear Interpolation:

Nearest neighbor method cannot be used for high resolution zooming. Bilinear interpolation is used to reduce the distortion in pictures. Bilinear interpolation is done in two directions row wise and column wise. Value of pixel is measured by using its nearest four neighbors. In this method, image of m*n size is selected. One another matrix of zero elements is taken. Both of matrixes are padded so that resultant matrix zeros elements. Then calculate the weighted average of four pixels. Bilinear interpolation is used to calculate the weighted average of the four neighboring pixels. Bilinear interpolation is fast and easy to implement [4][9]. Flowchart of bilinear interpolation is as follow:
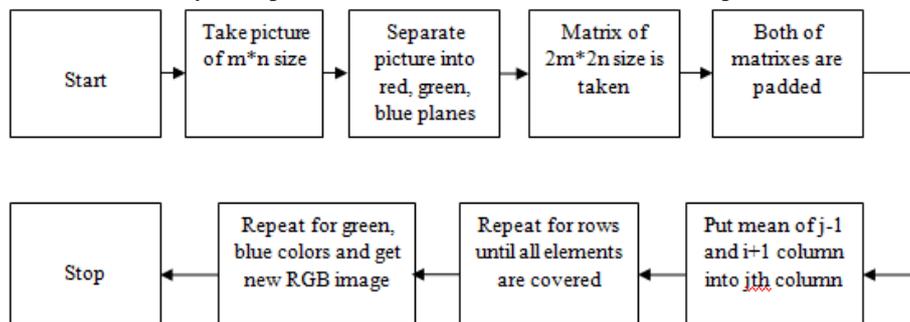

Fig. 1 Flowchart of Bilinear Interpolation

Fig.2 Processed image of Bilinear Interpolation (a) Original (b) Final Image

(a)

(b)

Fig. 2 Processed image of Bilinear Interpolation (a) Original (b) Final Image

B. Bicubic Interpolation:

It is better than nearest neighbor and bilinear interpolation methods. It is produced the smoother picture. Picture produces by it is near to the original picture. As compare to nearest neighbor, neighborhood of 16 pixels is used in bicubic interpolation method. For scaling pictures, bicubic interpolation is used. In bicubic interpolation, fine detail of picture is preserved. Processing time is more and picture quality is better in bicubic interpolation [3]. Flowchart of bicubic interpolation method is as follow:
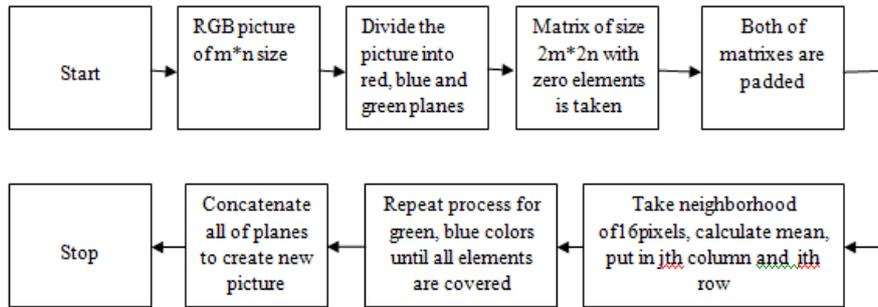

Fig. 3 Flowchart of Bicubic interpolation

(a)

(b)

Fig. 4: Processed Image of Bicubic Interpolation (a) Original (b) Final Image

C. Nearest neighbor interpolation

Nearest neighbor algorithm is simple and easy to implement. For zooming a picture, this algorithm is used. Value of nearest point is selected by this algorithm. Two steps are required to enlarge the picture. Firstly, it is created new locations and then assigned pixel values to new locations. Then pixel value of nearest neighbor is assigned to new pixel that is generated [4][6]. Flowchart of nearest neighbor algorithm is as follow:
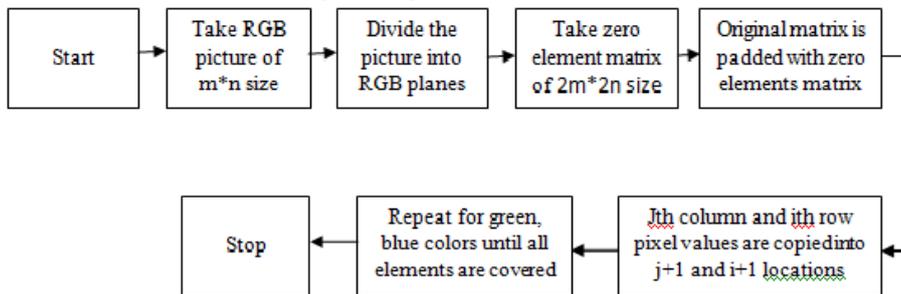

Fig.5 Flowchart of Nearest neighbor Interpolation

(a)

(b)

Fig.6: Processed Image of Nearest Neighbor Interpolation (a) Original (b) Final Image

Table 1 Comparison of interpolation methods

Interpolation method	Bilinear interpolation	Bicubic interpolation	Nearest neighbor interpolation
Pixel value	Use weighted average of two pixels	Use weighted average of four pixels	Use value of nearest pixels
Subjective Feelings	Blurring, not sharp	Sharper and fuzzy	Mosaic phenomenon
Image visibility	Jaggy, not clear	Better than bilinear	Not clear
performance	Poor	Better	Worst
Computation time	Less than bicubic	more	less
Speed	Slightly slower	fast	Simple and fast

IV. CONCLUSIONS

In this paper, we have studied about various methods of interpolation. All of these methods are compared on basis of different parameters such as pixel value, image visibility, performance, computation time and speed etc. Nearest neighbor interpolation method takes nearest value of pixel. Bilinear interpolation method takes neighborhood of four pixels and creates jaggy picture. Bicubic interpolation method is better as compared to bilinear and nearest neighbor interpolation methods. It produces high quality picture.

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