A Review of Image Retrieval Using Different types of Interpolation Techniques

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Abstract - *Interpolation is the process of changing image from one resolution to another without losing the image quality. Enhancement of image, zooming, resizing any many more are very important function of image interpolation method in image processing. Image enhancement is used in various fields like medical diagnosis, remote sensing, agriculture, geology, oceanography. Here in this paper, different interpolation algorithms have been reviewed. This paper gives overview about different interpolation techniques like Nearest Neighbour, Bi-Linear, Bi-Cubic, and B-Spline.*

Key Words: Image, Interpolation, Enhancement, Non-adaptive, Adaptive.

1. INTRODUCTION

The process of determining the values of a function at positions lying between its samples is called as interpolation. Fitting a continuous function through the discrete input samples interpolation achieves this process. This permits input values to be evaluated at arbitrary positions in the input, not just those defined at the sample points. Digital image is a signal, spatially varying in two dimensions. This signal is sampled and quantized to get values. All these values called pixels of image. When we increase the resolution of image from low to high, it is called up-sampling or up-scaling while reverse is called down sampling or down scaling. That is, interpolation reconstructs the signal lost in the sampling process by smoothing the data samples with an interpolation function [1].

Figure-1 shows the basic concept of how we can enlarge image using interpolation.
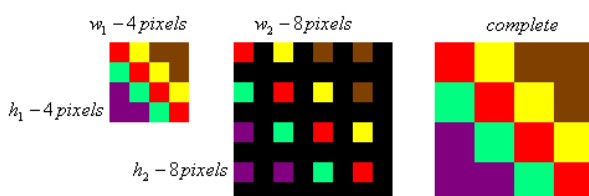

Fig-1: Image Interpolation

2. NEAREST NEIGHBOUR INTERPOLATION

The nearest neighbor is a simplest interpolation method from a computational standpoint, where each interpolated output pixel is assigned the value of the nearest sample point in the input image. This technique is also known as point shift algorithm and pixel replication [6]. The interpolation kernel for the nearest neighbor algorithm is defined as

$$h(x) = \begin{cases} 1 & 0 \leq |x| < 0.5 \\ 0 & 0.5 \leq |x| \end{cases}$$

The frequency response of the nearest neighbor kernel is

$$H(\omega) = \operatorname{sin} c\left(\frac{\omega}{2}\right)$$

3. BILINEAR INTERPOLATION

The bilinear interpolation algorithm is a method that uses the gray level values of the four surrounding pixels close to the mapped grid as shown in figure-2, that is, top-left, top-right, bottom left, and bottom-right around the spot where the new pixel is to be created[8]. The four red dots show the data points and the green dot is the point at which we want to interpolate.
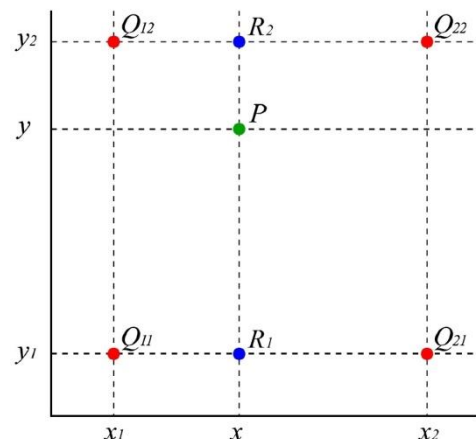

Fig.-2: Bilinear Interpolation

Suppose that we want to find the value of the unknown function f at the point (x, y). It is assumed that we know the value of f at the four points Q11 =(x1, y1), Q12 = (x1, y2), Q21 = (x2, y1), and Q22 = (x2, y2).

4. BICUBIC INTERPOLATION

Bicubic interpolation is best among all techniques. Bicubic interpolation takes a weighted average of the 16 pixels to calculate its final interpolated value. These pixels are at various distances from the unknown pixel. Closer pixels are given a higher weighting in the calculation [3]. Bicubic gives sharper images than previous two methods. This technique gives better result but take more computational time. When time is not a constraint then this technique give the best result among all the non-adaptive techniques.

The nearest 16 pixels are used to create an intermediate pixel F(p'q'). Therefore the output image quality will increase. In the below figure-3, an intermediate pixel F(p'q')[Near to F(p,q)] is created by interpolating nearest 4*4 pixels from F(p-1, q-1) to F(p+2,q+2).
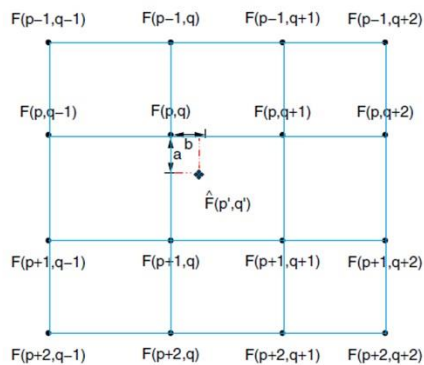

Fig-3: Bicubic interpolation

5. B-SPLINE INTERPOLATION

A B-spline of order n is a piecewise polynomial function of degree <n in a variable x. It is defined over a domain t $0 \leq x \leq t_m$, m = n. The points where x = t_j are known as knots or break-points. The number of internal knots is equal to the degree of the polynomial if there are no knot multiplicities. The knots must be in ascending order. The number of knots is the minimum for the degree of the B-spline, which has a non-zero value only in the range between the first and last knot. Each piece of the function is a polynomial of degree <n between and including adjacent knots. A B-spline is a continuous function at the knots. When all internal knots are distinct, its derivatives are also continuous up to the derivative of degree n-1. If internal knots are coincident at a given value of x, the continuity of derivative order is reduced by 1 for each additional knot[5].

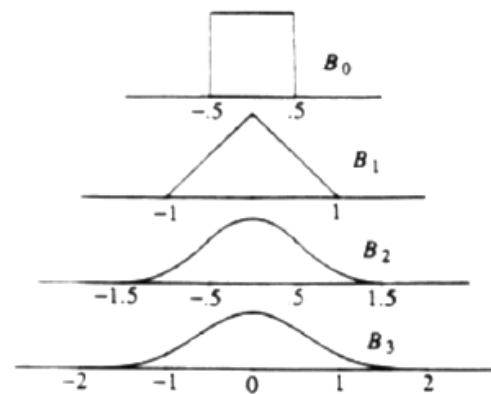The cubic B-spline B_3 is generated from convolving B_0*B_2. That is $B_3=B_0*B_0*B_0*B_0$.

Fig-4: low-order B-splines.

Figure-4 summarizes the shapes of these low-order B-splines.

6. DIFFERENT DOMAIN OF IMAGES

An image is a visual representation of something. In information technology, the term has several usages: An image is a picture that has been created or copied and stored in electronic form. An image can be described in terms of vector graphics or raster graphics . An image stored in raster form is sometimes called a bitmap . An image map is a file containing information that associates different locations on a specified image with hypertext links[2].

6.1 Portrait Image

A portrait is a painting, photograph, sculpture, or other artistic representation of a person, in which the face and its expression is predominant. The intent is to display the likeness, personality, and even the mood of the person.

Fig-5: Sculpture of Lion

6.2 Landscape Image

A picture representing a view of natural inland scenery or the countryside. An area of land that has a particular quality or appearance and particular area of activity. Landscape is done for a variety of reasons. Perhaps the most common is to recall a personal observation or experience while in the outdoors, especially when traveling. Others pursue it particularly as an outdoor lifestyle, to be involved with nature and the elements, some as an escape from the artificial world

Fig-6: Natural Scene

6.3 Human Face Image

The face is a central organ of sense and is also very central in the expression of emotion among humans and among numerous other species.

Fig-7: Face Expression

7. RESULT PARAMETER

Result parameter is a characteristic, feature, or measurable factor that can help in defining a particular system. A parameter is an important element to consider in evaluation or comprehension of an event, project, or situation. Parameter has more specific interpretations in mathematics, logic, linguistics, environmental science, and other disciplines.

7.1 Visual Properties of Interpolated Images

The first 8 are visual properties of the interpolated image the last is a computational property of the interpolation method[7]:

a) *Geometric Invariance:* The subject matter should not change by using interpolation methods in order to preserve the geometry and relative sizes.

b) *Contrast Invariance:* The method should preserve the overall luminance values of in an image and contrast of the image.

c) *Noise:* The method should not add noise or other artifacts to the image.

d) *Edge Preservation:* The method should preserve edges and boundaries and sharpen them where possible.

e) *Aliasing:* The method should not produce staircase edges.

f) *Texture Preservation:* The method should not blur or smooth textured regions.

g) *Over-smoothing:* The method should not produce undesirable piecewise constant or blocky regions.

h) *Application Awareness:* The method should produce appropriate results to the type of image and order of resolution.

i) *Sensitivity Parameter*s: The method should not be too sensitive to internal parameters that may vary from image to image.

7.2 Image intensity

This term refers to the brightness of a point in an image. The intensity of a pixel is determined by several quantities including the local value of a RGB, The amount of light reflected by a surface element depends on its micro-structure and the distribution of incident light. 2.2.3 Edge

- Edges are significant local changes of intensity in an image.

- Edges typically occur on the boundary between two different regions in an image.

- An edge can be defined as a set of contiguous pixel positions where an abrupt change of intensity (gray or color) values occur.

An edge in an image is a boundary or contour at which a significant change occurs in some physical aspect of an image, such as the surface reflectance, illumination or the distances of the visible surfaces from the viewer. Changes in physical aspects manifest themselves in a variety of ways, including changes in intensity, color, and texture.

Detecting edges is very useful in a no of contexts. For example in a typical image understanding task such as object identification, an essential step is to segment an image into different regions corresponded to different objects in the scene. Edge detection is the 1st step in image segmentation.

8. CONCLUSION

Basically, the Interpolation techniques concentrate on edges present in the image and works on minimizing the artifacts. This leads to the conclusion that different interpolation techniques provides better results both visually and quantitatively on different types of images. By applying Nearest Neighbor, Bi-Linear, Bi-Cubic, B-Spline interpolation techniques on the domain of Landscape, Portrait, Real Object, Human Face, Notice, Free Hand images following conclusion are carried out.

a) Nearest Neighbor Interpolation is better for those domain of images whose contain same number of pixel in large area of image have maximum scaling value like Real Object and Human Face image. But rest of domain whose need smooth edges and less artifacts, this interpolation is not good enough for those do- main of images.

b) Bi-Linear interpolation is better for those domain in which some blurriness is allowed have maximum scaling value like landscape images. Bilinear works quite well on Human Face and Notice Domain images. This technique is not suggested for portrait image because these image contain sharp line which convert into stair edges, which show bad visualization of portrait.

c) Bi-Cubic interpolation performed good on those domain of images which not follow same pattern on their architecture and contain curve also have scaling value like Real Object, Portrait, Human Face, Free Hand. But rest two domain follow same pattern in large area of image, so this technique not work properly on them

d) B-spline interpolation work properly comparative to other interpolation on almost all domain of images, because it find more accurate intermediate value using known pixel value.

This leads to be concluded that different interpolation techniques provides better results both visually and quantitatively on different domain of images.

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