IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 1 Issue 10, December 2014.
www.ijiset.com
ISSN 2348 – 7968

Study of Image Interpolation

Mrs. Amruta Savagave, Prof .A .P. Patil

Electronics & Telecommunication Department, Kolhapur, India
Email: amrutapep@gmail.com

Electronics Engg. Dept., Dr. J. J. Magdum College of Engineering, India
Email: appatil2013@gmail.com

Abstract

Interpolation is the process of transferring image from one resolution to another without losing image quality. In Image processing field, image interpolation is very important function for doing zooming, enhancement of image, resizing any many more. Conventional image interpolation methods suffer blurring problems in edge regions, so it is hard to produce sharp and clear visual effects. The traditional view of interpolation is to represent an arbitrary continuous function as a discrete sum of weighted and shifted synthesis functions in other words, a mixed convolution equation. An important issue is the choice of adequate synthesis functions that satisfy interpolation properties. Examples of finite-support ones are the square pulse (nearest-neighbor interpolation), the hat function (linear interpolation), the cubic Keys' function, and various truncated or windowed versions of the sinc function. On the other hand, splines provide examples of infinite-support interpolation functions that can be realized exactly at a finite, surprisingly small computational cost.

Keywords- Image Interpolation, Adaptive Interpolation, Non adaptive interpolation. Nearest Neighbor Interpolation, Bilinear Interpolation, Bicubic Interpolation

1. Introduction

Image interpolation addresses the problem of generating a high-resolution image from its low-resolution version. The model employed to describe the relationship between high-resolution pixels and low-resolution pixels plays the critical role in the performance of an interpolation algorithm. Conventional linear interpolation schemes (e.g., bilinear and bicubic) based on space-invariant models fail to capture the fast evolving statistics around edges and consequently produce interpolated images with blurred edges and annoying artifacts. Linear interpolation is generally preferred not for the performance but for computational simplicity. Many algorithms have been proposed to improve the subjective quality of the interpolated images by imposing more accurate models. Approximating continues function's value using discrete samples is called interpolation . Image interpolation is nowadays available in many image processing tools like Photoshop and other. Applications of image interpolation methods are image enlargement, image reduction, subpixel image registration, image decomposition and to correct spatial distortions and many more. figure 1 shows the basic concept of how can enlarge image using interpolation. Image interpolation occurs in all digital photos at some stage whether this be in Bayer demosaicing or in photo enlargement. It happens anytime you resize or remap (distort) your image from one pixel grid to another. Image resizing is necessary when you need to increase or decrease the total number of pixels, whereas remapping can occur under a wider variety of scenarios: correcting for lens distortion, changing perspective, and rotating an image. Even if the same image resize or remap is performed, the results can vary significantly depending on the interpolation algorithm. It is only an approximation, therefore an image will always lose some quality each time interpolation is performed.

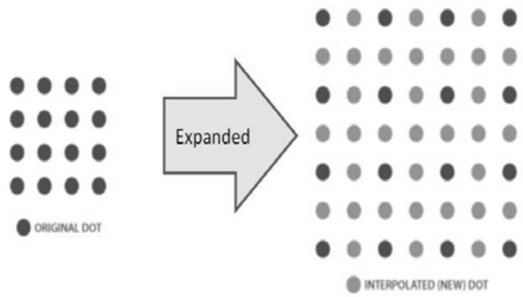

Fig.1 Basic Interpolation Concept

Model based recovery of continuous data from discrete data within a known range of abscissa. The reason for this preference is to allow for a clearer distinction between interpolation and extrapolation. The former postulates the existence of a known range where the model applies, and asserts that the deterministically recovered continuous data is entirely described by the discrete data, while the latter authorizes the use of the model outside of the known range, with the implicit assumption that the model is "good" near data samples, and possibly less good elsewhere.

Three most important hypothesis for interpoltionare:

1) The underlying data is continuous defined
2) Given data samples, it is possible to compute a data value of the underlying continuous function at any abscissa
3) The evaluation of the underlying continuous function at the sample points yields the same value as the data themselves

Two main categories are there for image interpolation algorithms called adaptive and non adaptive. In non adaptive method same procedure is applied on all pixels without considering image features while in a adaptive method, image quality and it's feature are considered before applying algorithm.

2.Non Adaptive Interpolation Algorithm

Conventional interpolation methods include nearest neighbor interpolation, bilinear interpolation and bicubic interpolation algorithm. The bilinear interpolation and bicubic interpolation smooth the data and keeping the low frequency content of the source image. Because they are not able to enhance the high frequencies or preserve the edges equally well, they may produce some annoying visual problems, such as aliasing, blurring or other artifact effects. It also includes spline, sinc, lanczos. Depending on their complexity, these use anywhere from 0 to 256 (or more) adjacent pixels when interpolating. The more adjacent pixels they include the more accurate they can become, but this comes at the expense of much longer processing time. These algorithms can be used to both distort and resize a photo.

Various adaptive interpolation algorithms have already been developed to solve the artifact effects. Without thinking or considering the content of image, in this method simply apply some computational. Normally commercial product like Adobe Photoshop uses this kind of interpolation methods.

2.1 Nearest Neighbor Interpolation

Nearest neighbor is the most basic and requires the least processing time of all the interpolation algorithms because it only considers one pixel, the closest one to the interpolated point. This has the effect of simply making each pixel bigger. This method is very simple and requires less computation as it use nearest neighbor's pixel to fill interpolated point. This method is just copies available value, not interpolate value as it doesn't change values.

ISSN 2348 – 7968

2.2 Bilinear Interpolation

In this method,,interpolated point is filled with four closest pixel's weighted average. In this method use two linear interpolations, in horizontal direction and then linear interpolation in vertical direction. So there is need to calculate four interpolation function for grid point in Bilinear Interpolation. This results in much smoother looking images than nearest neighbor.

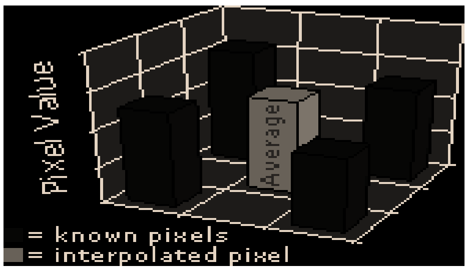

Fig.2 Bilinear Interpolation

Figure.2 is for a case when all known pixel distances are equal, so the interpolated value is simply their sum divided by four.

2.3 Bicubic Interpolation

Bicubic goes one step beyond bilinear by considering the closest 4x4 neighborhood of known pixels for a total of 16 pixels as shown in figure 3. Since these are at various distances from the unknown pixel, closer pixels are given a higher weighting in the calculation. Bicubic produces noticeably sharper images than the previous two methods, and is perhaps the ideal combination of processing time and output quality. For this reason it is a standard in many image editing programs (including Adobe Photoshop), printer drivers and in-camera interpolation.

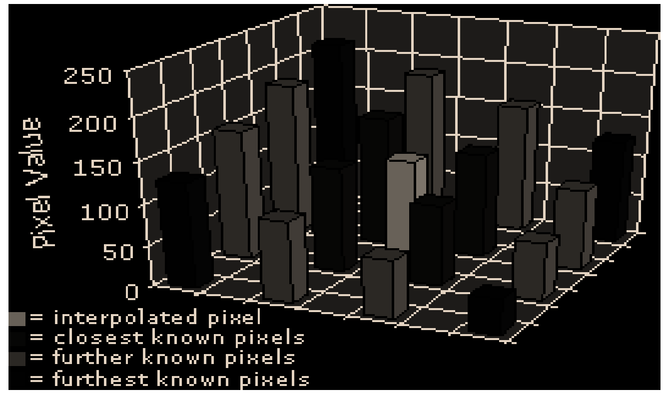

Fig.3Bicubic Interpolation

2.4 Filtering-based (Re-sampling) Techniques

Transforming image pixel from one coordinate to another (different resolution) is called Re-sampling process. Digital image is discrete function in two dimensions so there is need of 2D filtering or convolution. But it is computationally costly. So separate 2D function and apply it first row wise and then column wise on 1D. There is a different filters used for interpolation algorithm. Filters are used for blur and noise removal as well as edge identification.

Figure 4 shows the comparison of three (Nearest neighbor, Bilinear and Bicubic Interpolation) non adaptive methods**.**

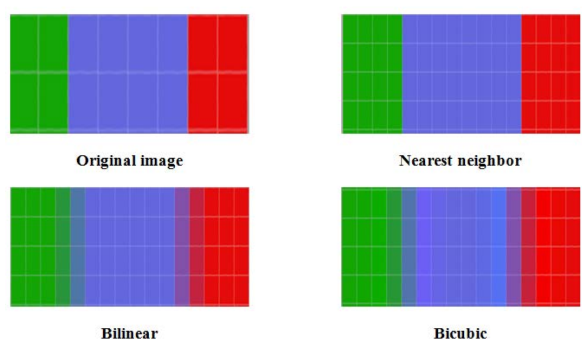

Fig.4 Comparison of non adaptive methods

ISSN 2348 – 7968

3. Adaptive Algorithm

Include many proprietary algorithms in licensed software such as: Qimage, PhotoZoom Pro, Genuine Fractals and others. Many of these apply a different version of their algorithm (on a pixel-by-pixel basis) when they detect the presence of an edge, aiming to minimize unsightly interpolation artifacts in regions where they are most apparent. These algorithms are primarily designed to maximize artifact-free detail in enlarged photos, so some cannot be used to distort or rotate an image. Adaptive algorithm basically uses some of the image features and improves interpolation result. Adaptive algorithm works based on different intensity present and local structure of image. Many adaptive interpolation algorithms have been proposed which enhance edges in images. Local gradient information can also be used to enhance non adaptive interpolation algorithm. Normal problem with interpolation technique is blurring and blocking artifacts. This can be solved using directional interpolation. Adaptive interpolation techniques spatially adapt the interpolation coefficients to better match the local structures around the edges. Iterative methods such as PDE-based schemes [6], [7] and projection onto convex sets (POCS) schemes [8], [9], constrain the edge continuity and find the appropriate solution through iterations. Edge-directed interpolation techniques [10], [11] employ a source model that emphasizes the visual integrity of the detected edges and modify the interpolation to fit the source model.

3.1 Recent interpolation Algorithms

It includes some recent algorithms for interpolation, Xin Li, and Michael T. Orchard, has given their ideas in paper “New Edge-Directed Interpolation” A novel noniterative orientation adaptive interpolation scheme for natural-image sources. motivation This idea comes from the fundamental property of an ideal step edge (known as geometric regularity), i.e., that the I mage intensity field evolves more slowly *along* the edge orientation than *across* the edge orientation. Geometric regularity has important effects on the visual quality of a natural image such as the sharpness of edges and the freedom from artifacts. Since edges are presumably very important features in natural images, exploiting the geometric regularity of edges becomes paramount in many image processing tasks. In the scenario of image interpolation, an orientation-adaptive interpolation scheme exploits this geometric regularity [12].

Xiao-feng Wang, He-fei Ling, proposed “An Edge-Adaptive Interpolation Algorithm for Super-Resolution Reconstruction” Here they construct high resolution image using bilinear interpolation and detect edges. Then edges are refined using geometric duality between the low-resolution covariance and the high-resolution covariance and local structure feature [1].

Bing Yang, Zhiyong Gao, Xiaoyun Zhang, proposed “Principal Components Analysis-Based Edge-Directed Image Interpolation” Here the gradient directions are explicitly estimated with a statistical-based approach. The local dominant gradient directions are obtained by using principal components analysis (PCA) on the four nearest gradients. The angles of the whole gradient plane are divided into four parts, and each gradient direction falls into one part. Then they implement the interpolation with one-dimension (1-D) cubic convolution interpolation perpendicular to the gradient direction [4].

Sanjay Kumar Maurya, Pavan Kumar Mishra, proposed “Image Enhancement by Intensity Based Interpolation and Selective Threshold”, It includes one technique which determines edges by comparing the intensity variations between center pixel and its neighboring pixels of window size 55. On the basis of designed thresholds, extrapolated blank pixels are filled [3].
Lei Zhang, Xiaolin Wu proposed, “An Edge-Guided Image Interpolation Algorithm via Directional Filtering and Data Fusion”, For edge information they have partition pixels into two directional and orthogonal subsets. Directional interpolation is made for each Subset and two interpolated values are fused. Algorithm presented in [5] work for gray scale images only. .

Sapan Naik, Viral Borisagar, proposed " A novel Super Resolution Algorithm using Interpolation and LWT based denoising method "Here they do the modification so that algorithm works for RGB image also. They have stored each R,G and B components of one image into three different images of two dimension (same as grayscale image) and give that as a input to original algorithm. Finally they have merged all three output arrays into single RGB image [2].

4. Application

Among biomedical applications where interpolation is quite relevant, the most obvious are those where the goal is to modify the sampling rate of pixels (picture elements) or voxels (volume elements). This operation, named rescaling, is desirable when an acquisition device say, a scanner has a nonhomogeneous resolution, typically a fine within-slice resolution and a coarse across-slice resolution. In this case, the purpose is to change the aspect ratio of voxels in such a way that they correspond to geometric cubes in the physical space. Often, the across-slice resolution is modified to match the within-slice resolution, which is left unchanged. This results in a volumetric representation that is easy to handle (e.g., to visualize or to rotate) because it enjoys homogenous resolution.

The relevance of interpolation is also obvious in more advanced visualization contexts, such as volume rendering. There, it is common to apply a texture to the facets that compose the rendered object . Although textures may be given by models (procedural textures), this is generally limited to computer graphics applications; in biomedical rendering, it is preferable to display a texture given by a map consisting of true data samples. Due to the geometric operations involved (e.g., perspective projection), it is necessary to resample this map, and this resampling involves interpolation. In addition, volumetric rendering also requires the computation of gradients, which is best done by taking the interpolation model into account.

In general, almost every geometric transformation requires that interpolation be performed on an image or a volume. In biomedical imaging, this is particularly true in the context of registration, where an image needs to be translated, rotated, scaled, warped, or otherwise deformed, before it can match a reference image or an atlas. Obviously, the quality of the interpolation process has a large influence on the quality of the registration

ISSN 2348 – 7968

The data model associated to interpolation also affects algorithmic considerations. For example, the strategy that goes by the name of multiresolution proposes to solve a problem first at the coarse scale of an image pyramid, and then to iteratively propagate the solution at the next finer scale, until the problem has been solved at the finest scale. In this context, it is desirable to have a framework where the interpolation model is consistent with the model upon which the image pyramid is based. The assurance that only a minimal amount of work is needed at each new scale for refining the solution, is only present when the interpolation model is coherent with the multiresolution mode.

References

[1] Xiao- feng Wang, He-fei Ling, "An Edge-Adaptive Interpolation Algorithm for Super-Resolution Reconstruction", 2010 International Conference on Multimedia Information Networking and Security.

[2] Sapan Naik, Viral Borisagar," A novel Super Resolution Algorithm using Interpolation and LWT based denoising method ", IJIP journal, VOL. 6, issue 4,2012.

[3] Sanjay Kumar Maurya, Pavan Kumar Mishra, "Image Enhancement by Intensity Based Interpolation and Selective Threshold",2012 International Conference on Communication Systems and Network Technologies.

[4] Bing Yang, Zhiyong Gao, Xiaoyun Zhang, "Principal Components Analysis-Based Edge-Directed Image Interpolation", 2012 IEEE International Conference on Multimedia and Expo (ICME).

[5] Lei Zhang, Xiaolin Wu, "An Edge-Guided Image Interpolation Algorithm via Directional Filtering and Data Fusion", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 15, NO. 8, AUGUST 2006.

[6] B. Ayazifar and J. S. Lim, "Pel-adaptive model-based interpolation of spatially subsampled images," in Proc. IEEE Int. Conf. Acoustics, Speech,Signal Processing, vol. 3, 1992, pp. 181–184.

[7] B.S.Morse and D.Schwartzwald, "Isophote-based interpolation," inProc. IEEE Int. Conf. Image Processing, vol. 3, 1998, pp. 227–231.

[8] K. Ratakonda and N. Ahuja, "POCS based adaptive image magnification," in *Proc. IEEE Int. Conf. Image Processing*, vol. 3, 1998, pp. 203–207

.[9] D. Calle and A. Montanvert, "Superresolution inducing of an image," in*Proc*. IEEE Int. Conf. Image Processing, vol. 3, 1998, pp. 232–235.

[10] K. Jensen and D. Anastassiou, "Subpixel edge localization and the interpolation of still images," IEEE Trans. On Image Processing, vol. 4, pp. 285–295, Mar. 1995.

[11] J.Allebach and P. W. Wong, "Edge-directed interpolation," in *Proc*. IEEE Int. Conf. Image Processing, vol. 3, 1996, pp. 707– 710.

[12] X. Li et.al., "New edge-directed interpolation," IEEE trans. on Image Processing, Vol. 10, No 10, October 2001, pp.1521-1527