International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 6, June - 2013

A Comparison Study On Different Interpolation Methods Based On Satellite Images

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***Abstract* – Satellite images are used in many applications such as agriculture, geology, forestry, landscape, regional planning, education, biodiversity conservation and warfare. Satellite imagery is also used in oceanography in deducing changes to land formation, water depth and sea bed, by color caused by earthquakes, volcanoes, and tsunamis. Any type of images especially for satellite images the resolution is important factor. In this paper satellite images are enhanced with different interpolation methods and perform the comparison also.**

Key Terms – Resolution, Scaling, Interpolation, Peak Signal to Noise Ratio.

I. INTRODUCTION

The resolution is an important factor in the case of digital images. Especially for satellite images the resolution is very important. Because satellite images are used in the fields of forestry, landscape, regional planning, education, biodiversity conservation and warfare. Some of the software's used the satellite images as the input for land development, regional planning and agriculture etc. So resolution is very important. For the high resolution images the high-resolution CCD cameras coupled large lenses to take pictures of the ground right below them as they pass over. In some situations the satellite provides low resolution images. This low resolution images are converted to high resolution images by using different techniques. Scaling is one of the solution to this, but scaling of an image leads to loss of high frequency components.

The best solution to increase the resolution of an image with high frequency component is interpolation technique. Interpolation techniques mainly are of three types, nearest neighbor interpolation, bilinear interpolation and bicubic interpolation. In these three Bicubic is better. This result taken on the bases of visual resulst and time taken for providing the output. The resolution of following types, spatial, spectral, temporal, and radiometric. Spatial resolution is defined as the pixel size of an image, spectral resolution is defined by the wavelength interval size, temporal resolution is defined by the amount of time that passes between imagery collection periods for a given surface location; and radiometric resolution is defined as the ability of an imaging system to record many levels of brightness (contrast for example). In this paper focused on spatial resolution. The paper is organized as follows. Section II discribe the difference in scaling and interpolation section III shows the anaysis part.

(a) (b)

Fig.1.a) image after scaling b) image after interpolation

II. SCALING AND INTERPOLATION

Image scaling is the process of resizing a digital image. And scaling is a non-trivial process which involves a trade-off between efficiency, smoothness and sharpness. An image after scaling, the size of an image is reduced or enlarged. But the interpolation methods which provide enhanced image and which preserve the high frequency components also. The Fig. 1 shows the difference in image after scaling and interpolation. In interpolation technique actually guessing the new value is performed. And the interpolation is defined as follows, An image f(x,y) tells us the intensity values at the integral lattice locations, i.e., when x and y are both integers. Image interpolation refers to the "guess" of intensity values at missing locations, i.e., x and y can be arbitrary. The interpolation techniques explained below;

A. Nearest Neighbor Interpolation

Nearest neighbor interpolation is also known as proximal interpolation or, in some contexts, point sampling and which is a simple method in interpolation. The nearest neighbor algorithm selects the value of the nearest point and does not consider the values of neigh-boring points at all. The algorithm is very simple to implement and is commonly used. The point $p(x,y)$ on the horizontal axis and the intensity of its neighboring pixel, $p(x,y+1)$,on the vertical axis. Because adjacent pixels tend to have the same intensity level. Each interpolated output pixel is assigned the value of the nearest pixel in the input image. The nearest neighbor can be any one of the upper, lower, left and right pixels. For example, consider the Fig. 2 which shows the interpolated points and its intensity range. In this Fig.2 the white squares are the points which are to be interpolated. Consider the square portion for interpolation then the image values like in the Fig.2.

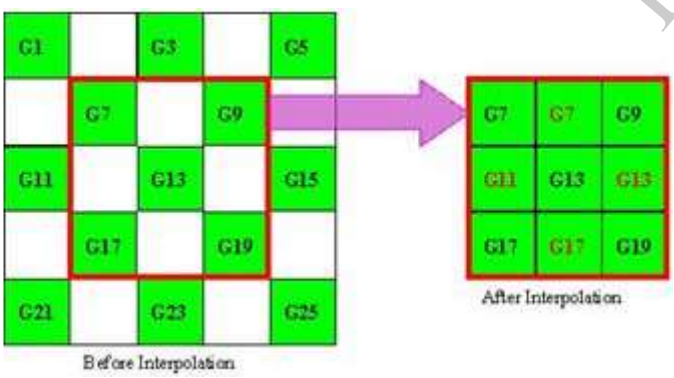


Fig.2.The interpolated points and its intensity range

Advantages

The nearest neighbor interpolation technique is very simple and less complex.

Disadvantages

The nearest neighbour interpolation artefacts such as blurring, and edge halos.

B. Bilinear Interpolation

Bilinear Interpolation technique is second interpolation method. And which is based on four neighbour pixels. Suppose that we want to find the value of the unknown function f at the point $P = (x, y)$. It is assumed that we know the value of f at the four points $Q_{11} = (x_1, y_1)$, $Q_{12} = (x_1, y_2)$, $Q_{21} = (x_2, y_1)$, and $Q_{22} = (x_2, y_2)$. The Fig. 3 shows the pictorial representation of these points and also the interpolated point, p(x,y).

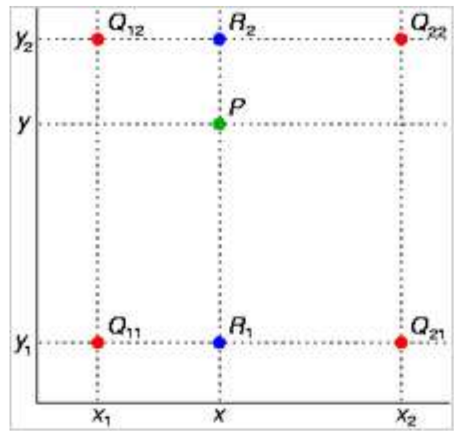


Fig.3. Bilinear Interpolation

We first do linear interpolation in the x-direction. This yield

$$f(R_1) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21})$$

where $R_1 = (x, y_1)$,

$$f(R_2) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22})$$

where $R_2 = (x, y_2)$.

We proceed by interpolating in the y-direction.

$$f(P) \approx \frac{y_2 - y}{y_2 - y_1} f(R_1) + \frac{y - y_1}{y_2 - y_1} f(R_2).$$

This gives us the desired estimate of $f(x, y)$.

Unlike other interpolation techniques such as nearest neighbour interpolation and bicubic interpolation, bilinear interpolation uses only the 4 nearest pixel values which are located in diagonal directions from a given pixel in order to find the appropriate colour intensity values of that pixel. It then takes a weighted average of these 4 pixels to arrive at its final, interpolated value. The weight on each of the 4 pixel values is based on the computed pixel's distance (in 2D space) from each of the known points.

Advantages

Bilinear interpolation is fast and simple to implement. Unlike other interpolation techniques such as nearest neighbour interpolation and bicubic interpolation, bilinear interpolation uses only the 4 nearest pixel values which are located in diagonal directions from a given pixel in order to find the appropriate colour intensity values of that pixel. This algorithm reduces some of the visual distortion caused by resizing an image

Disadvantages

Bilinear interpolation tends, however, to produce a greater number of interpolation artefacts such as blurring, and edge halos. Bilinear interpolation creates some patterns which are not necessarily acceptable depending on what you intend to use the result of the interpolation for. This algorithm takes more time technique and also more complex than nearest neighbour technique.

C. Bicubic Interpolation

In image processing, bicubic interpolation is often chosen over bilinear interpolation or nearest neighbour [1] in image resembling, when speed is not an issue. In contrast to bilinear interpolation, which only takes 4 pixels (2x2) into account, bicubic interpolation considers 16 pixels (4x4). Images resembled with bicubic interpolation are smoother and have less interpolation distortion

Suppose the function values f and the derivatives f_x, f_y and f_{xy} are known at the four corners $(0,0)$, $(1,0)$, $(0,1)$, and $(1,1)$ of the unit square. The interpolated surface can then be written

$$p(x,y) = \sum_{i=0}^{3}\sum_{j=0}^{3} a_{ij} x^i y^j.$$

The interpolation problem consists of determining the 16 coefficients a_{ij}. Matching $p(x,y)$ with the function values yields four equations,

1. $f(0,0) = p(0,0) = a_{00}$
2. $f(1,0) = p(1,0) = a_{00} + a_{10} + a_{20} + a_{30}$
3. $f(0,1) = p(0,1) = a_{00} + a_{01} + a_{02} + a_{03}$
4. $f(1,1) = p(1,1) = \sum_{i=0}^{3} \sum_{j=0}^{3} a_{ij}$

Advantages

Bicubic interpolation is often chosen over bilinear interpolation or nearest neighbour in image resembling, when speed is not an issue. Because it provide a less interpolation distortion.

Disadvantages

Complex calculation compared to other two method described above. Greater time need to generate the output compared to bilinear and nearest neighbor methods.

III. ANALYSIS

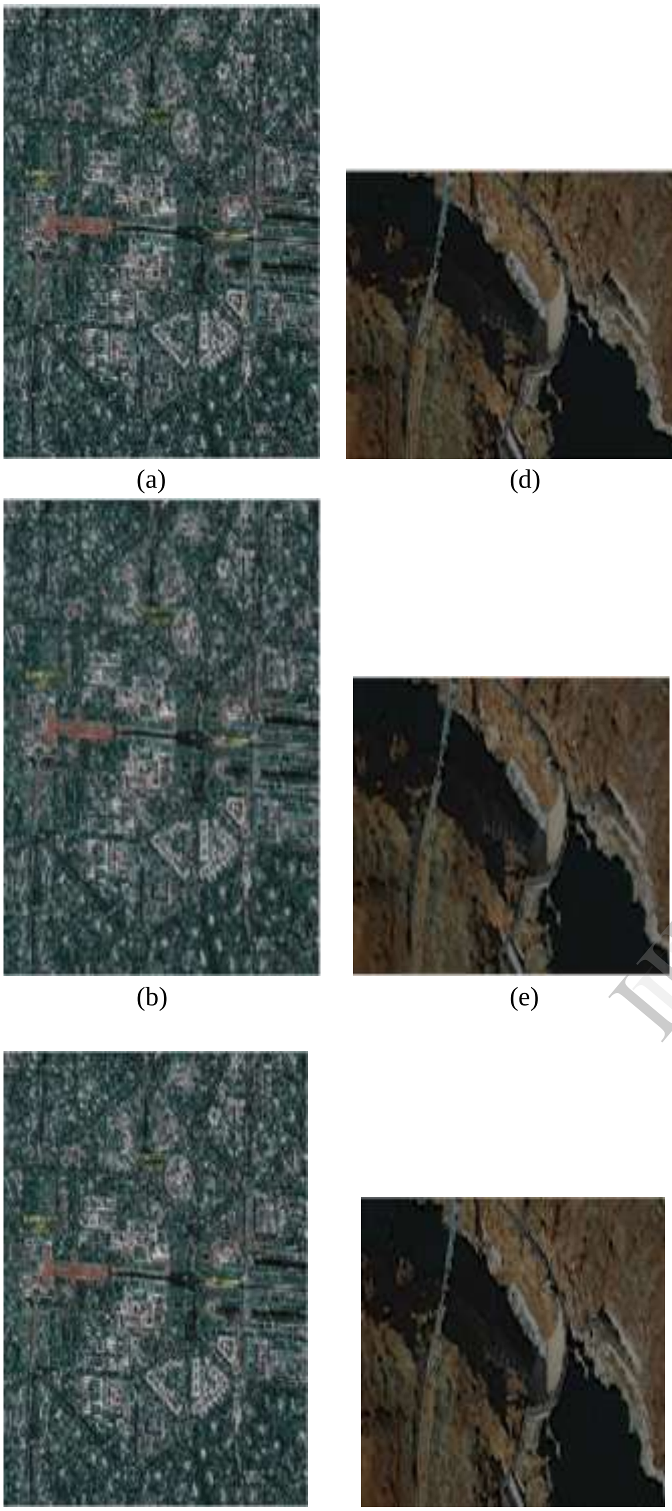
The different interpolation technique is analyzed in this section. The input images are shown in Fig. 4

(a)

(b)

Fig. 4 Input Images For Interpolation Study

The image a) in Fig 4 is 240 × 210. And the b) in fig 4 is 250 ×114. The time difference and visual results of these images for the three interpolation methods given in below.



(a) (d) (b) (e) (c) (f)

Fig. 5.Out Put Image After (a) & (d) nearest neighbor (b) & (e) bilinear (c) & (f) Bicubic - interpolation

Interpolation Methods	Time in seconds Fig 4.a	Fig 4.b
Nearest Neighbor	7.499067	6.860366
Bilinear	7.477320	6.126771
Bicubic	7.778218	6.355854

Table 1 Time Taken For Different Interpolation

IV.CONCLUSION

The results show the Bicubic interpolation method is better than other two methods. The nearest neighbor and bilinear interpolation methods have less time to produce output. But Bicubic interpolation need more time than other two but it produce better output. The bilinear interpolation is based on 4 points and Bicubic interpolation is based on 16 points so it take some time to calculate the new pixels. When spped is not an issue, the Bicubic is better than others.

V. REFERENCES

[1] Hasan Demirel and Gholamreza Anbarjafari," Discrete Wavelet Transform-Based Satellite Image Resolution Enhancement," *IEEE transactions on geoscience and remote sensing*, vol. 49, no. 6, June 2011.

[2] YananWang, "An Improved Interpolation Algorithm using Nearest Neighbour,"IEEE *transaction on audio language and image processing (ICALIP*), international conference ,Nov 2010.

[3] Mayuri D Patil, Prof. Surbhi Khare,"Techniques Used For Image Resolution Enhancement," *International Journal on Computer Science and Engineering (IJCSE)*,2005

[4] Shuai Yuan, Masahide ABE, Akira Taguchi And Masayuki Kawamata ,"High Accuracy Bicubic Interpolation," *Department of electronic engineering, tohoku university, department of electrical and electronic engineering, musashi institute of technology*.

[5] H. Demirel and G. Anbarjafari, "Satellite image resolution enhancement using complex wavelet transform," *IEEE Geosci. Remote Sens. Lett*., vol. 7, no. 1, pp. 123–126, Jan. 2010.

[6] G. Anbarjafari and H. Demirel, "Image super resolution based on interpolation of wavelet domain high frequency sub-band and the spatial domain input image," *ETRI J.*, vol. 32, no. 3, pp. 390–394, Jun. 2010.