IN THE CIRCUIT COURT OF THE SIXTH JUDICIAL CIRCUIT
OF THE STATE OF FLORIDA IN AND FOR PASCO COUNTY
CRC14-00216CFAES

Filed For Record Pasco County, Florida 2021 NOV 23 PM 12:02 Nikki Alvarez-Sowles Clerk & Comptroller Pasco County Florida

STATE OF FLORIDA

V.

CURTIS J. REEVES

SECOND SUPPLEMENT TO STATE'S RESPONSE TO DEFENDANT'S MOTION TO EXCLUDE PROOF AND TESTIMONY PERTAINING TO THE STATE'S FORENSIC VIDEO EXPERT ANTHONY IMEL

COMES NOW, BRUCE BARTLETT, State Attorney for the Sixth Judicial Circuit in and for Pasco County, Florida, by and through the undersigned Assistant State Attorney, hereby files this *Second Supplement To State's Response to the Defendant's Motion To Exclude Proof And Testimony Pertaining To The State's Forensic Video Expert Anthony Imel* as follows:

ADDITIONAL EXHIBITS

Exhibit #6 Baboo and Devi, *An Analysis of Different Resampling Methods in Coimbatore, District*, Global Journal of Computer Science and Technology, Vol. 10 Issue 15 (Ver.1.0) December 2010, page 61. 6 pages.

Exhibit #7 Titus and George, *A Comparison Study On Different Interpolation Methods Based on Satellite Images,* International Journal of Engineering Research & Technology, Vol. 2 Issue6, June - 2013. 4 pages.

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that a copy of the foregoing Supplement To State's Response To Defendant's Motion To Exclude Proof And Testimony Pertaining To The State's Forensic Video Expert Anthony Imel was furnished to Richard Escobar, Esq., Attorney for the Defendant, at 2917 West Kennedy Blvd., Suite 100, Tampa, FL 33609-

3163, by U.S. Mail/Personal Service/email rescobar@escobarlaw.com, this 17th day of November, 2021.

BRUCE BARTLETT, State Attorney
Sixth Judicial Circuit of Florida

By: [redacted]
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An Analysis of Different Resampling Methods in Coimbatore, District

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GJCST Classification I.4.6, I.3

Abstract-**Image pre-processing of satellite Imagery. In order to actually geometrically correct the original distorted image, a procedure called resampling is used to determine the digital values to place in the new pixel locations of the corrected output image. The resampling Process calculate the new pixel values from the original digital pixel values in the uncorrected image. When remote sensing has been used to create an image, it needs to undergo some form of validation procedure using observational and/or sampling techniques. Failure to do so will reduce the confidence in the final product.This study describes the three methods applied in Coimbatore district. This study is used to evaluate the three resampling methods and how they are vary from their pixel calculation and accuracy.**

*Keywords:*Resampling,Satteliite imagery,pixel location

I. INTRODUCTION

When the first satellite, Sputnik, was launched in 1957 no one could have foreseen how its diverse its use would become. Today, we have Direct TV, On-Star, XM Radio and live up-to-the-second television coverage from every corner of the world. Today, satellite information is being relayed back to earth every second of every day. Before Sputnik had completed it first orbit it had relayed the first data back to earth. And it was not the "oldies" station on XM Radio. It was environmental data. More than forty years later, the use of satellite imaging continues as the most popular provider of environmental monitoring. With recent demands for new levels of data we are presented with the problem of how to manipulate our new raw satellite images so that these images can be integrated with pre-existing environmental observations and methods.In order to retrieve, manipulate and process raw satellite images we make use of commercial computer software, in particular ERDAS Imagine for Visualizing Images. ERDAS Imagine is used for data visualization and analysis of satellite images. With a full understanding the use of key components of the ERDAS, we are able to customize, compose and modify algorithms. This allows us to prompt and direct ERDAS to meet our specific needs and tailor, to our needs, the processing of the satellite data.Once the raw remote sensing digital data has been acquired, it is then processed into usable information. Analog film photographs are chemically processed in a darkroom whereas digital images are processed within a computer. Processing digital data involves changing the data to correct for certain types of distortions. Whenever data is changed to correct for one type of distortion, the possibility of the creating another type of distortion exists. The changes made to remote sensing data involve two major operations: *preprocessing* and *postprocessing*.The preprocessing steps of a remotely sensed image generally are performed before the postprocessing enhancement, extraction and analysis of information from the image. Typically, it will be the data provider who will preprocess the image data before delivery of the data to the customer or user. Preprocessing of image data often will include *radiometric correction* and *geometric correction*. lGeometric corrections are made to correct the inaccuracy between the location coordinates of the picture elements in the image data, and the actual location coordinates on the ground. Several types of geometric corrections include system, precision, and terrain corrections. Geometric correction contains two methods that is Parametric and Non-Parametric. Non-parametric method establishes mathematical relationships (mapping polynomials) between the coordinates of pixels in an image and the corresponding coordinates of those points on the ground (via a map). Two steps are involved in non-parametric corrections 1. Rectification 2. Resampling. Step one used to Calculate new output pixel locations (X, Y) and Relate image location to map location using a "mapping polynomial" function.Step two involves in the process of extrapolating data values to a new grid. Resampling is the step in rectifying an image that calculates pixel values from the original data grid. This also involves in determination of DN values to fill in the output matrix of the rectified or registered image.There are three methods in resampling:

- Nearest Neighbour
- Bilinear Interpolation
- Cubic convolution

II. NEAREST NEIGHBOUR

Nearest neighbor is a resampling method used in remote sensing. This resampling uses the digital value from the pixel in the original image, which is nearest to the new pixel location in the corrected image. This is the simplest method and does not alter the original values, but may result in some pixel values being duplicated while others are lost. This method also tends to result in a disjointed or blocky image appearance.The approach assigns a value to each "corrected" pixel from the nearest "uncorrected" pixel. The advantages of nearest neighbor include simplicity and the ability to preserve original values in the unaltered scene. The disadvantages include noticeable position errors, especially along linear features where the realignment of pixels is obvious.

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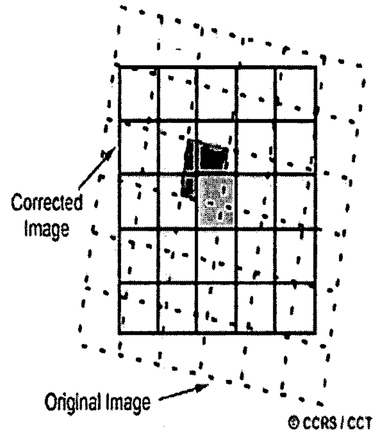

Figure 2.Nearest Neighbor pixel Calculation

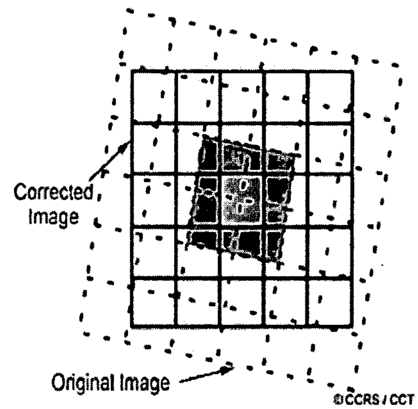

Figure3.Bilenear Interpolation

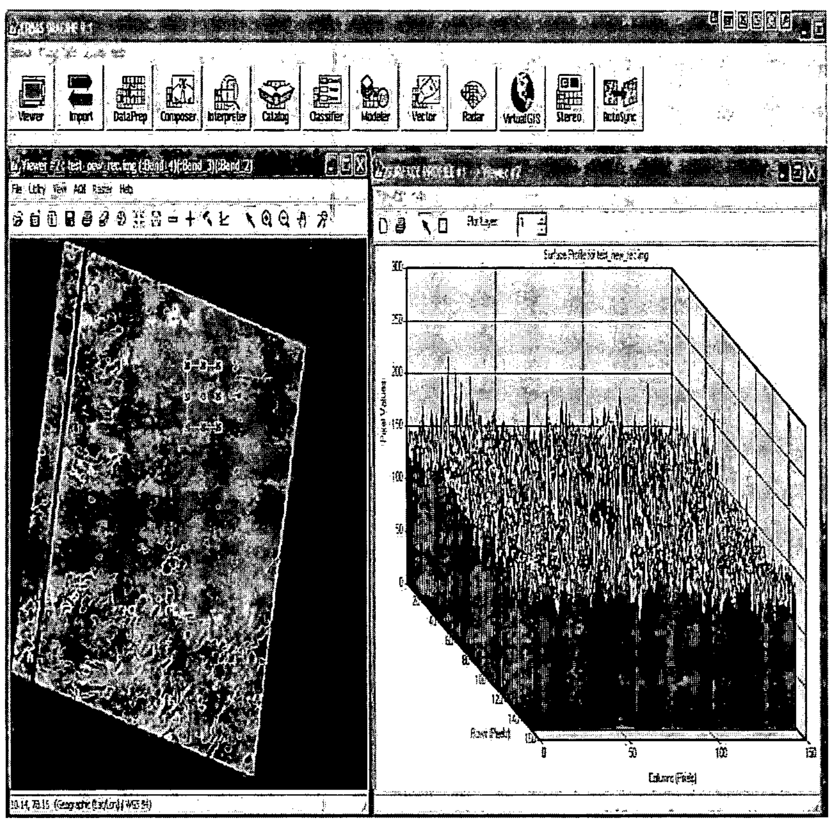

Figure.2.1 Surface profile of Nearest Neighbor resampling method

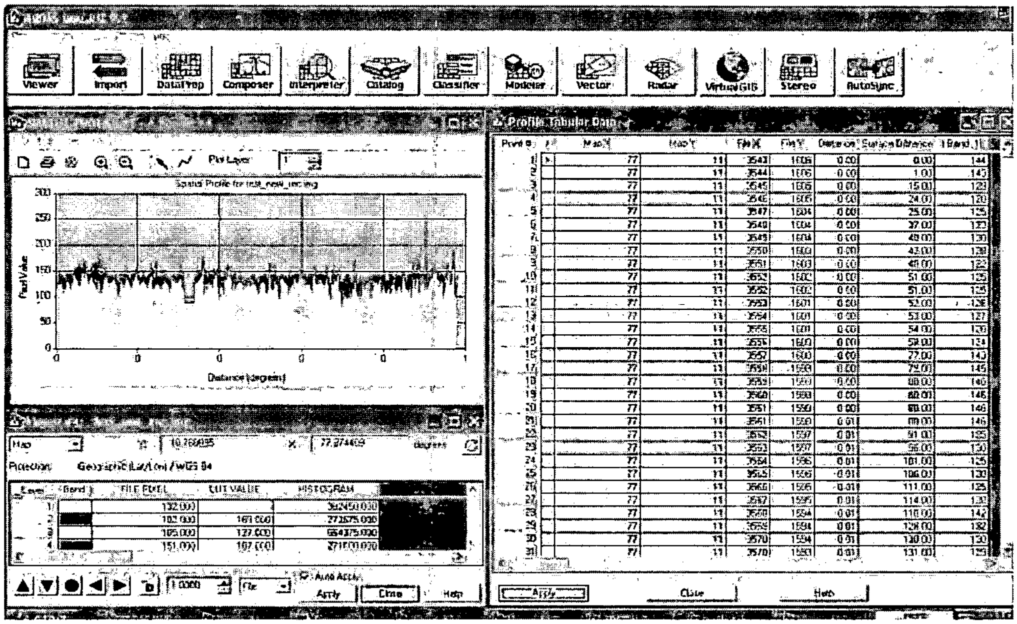

Figure. 2.2 pixel, histogram and spatial profile details of nearest neighbor

III. BILINEAR INTERPOLATION

Bilinear can refer to bilinear filtering or bilinear interpolation. Bilinear filtering is a method used to smooth out when they are displayed larger or smaller than they actually are. Bilinear filtering uses points to perform bilinear interpolation. This is done by interpolating between the four pixels nearest to the point that best represents that pixel (usually in the middle or upper left of the pixel). Bilinear interpolation resampling takes a weighted average of 4 pixels in the original image nearest to the new pixel location

The averaging process alters the original pixel values and creates entirely new digital values in the output image. This may be undesirable if further processing and analysis, such as classification based on spectral response is to be done. If this is the case,resampling may best be done after the classification process.It is shown figure 2.This resampling method assigns the average digital number (DN) of the four pixels closest to the input pixel (in a 2x2 window) to the corresponding output pixel. The mathematical function is bilinear.When apply this method in the coimbatore imagery we can get the following result in the figure 2.

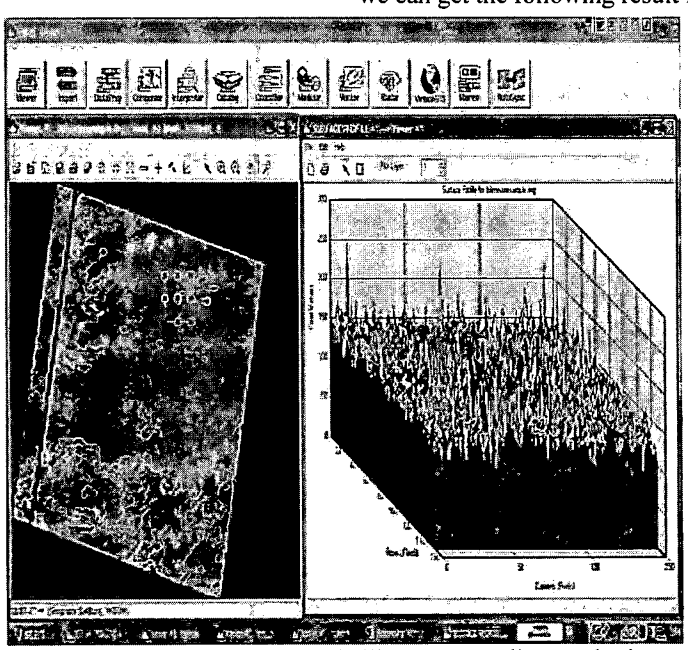

Figure 2.1Surface profile of bilinear resampling method

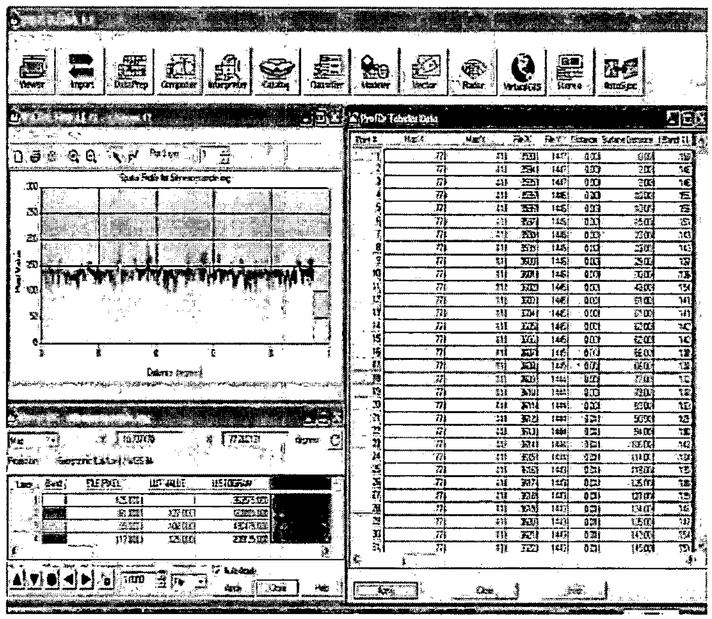

Figure 2.2.pixel,histogram and spatial profile details of bilinear resampling

IV. CUBIC CONVOLUTION

Cubic convolution is a method used to determine the gray levels in an image. This is determined by the weighted average of the 16 closest pixels to the input coordinates. Then that value is assigned to the output coordinates. This method is slightly better than bilinear interpolation, and it does not have the disjointed appearance of nearest neighbor interpolation. Cubic convolution requires about 10 times the computation time required by the nearest neighbor method. This resampling calculates a distance weighted average of a block of sixteen pixel from the original image which surround the new output pixel location

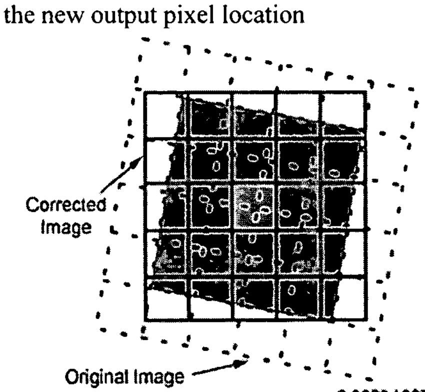

Figure 4 Cubic Convolution

This resampling method assigns the average DN of the sixteen pixels closest to the input pixel (in a 4x4 window) to the corresponding output pixel. The mathematical function is cubic.

V. RESULT AND DISCUSSION

Every one method has some advantage and disadvantage for some type of data,when compare result of surface and spatial profile of nearest neighbor resampling method the Cubic Convolution is gives the better result in coimbatore imagery.we can see the difference between these method in the following figures.Figure 5 shows the result of nearest neighbor and bilenear interpolation methods.In figure 5.1 we see the difference between Bilinear Interpolation and Cubic Convolution. The advantage of Nearest Neighboris extremes subtletie sare not lost and fast computation is possible. But the distadvantage of this method is "stairstepped".That is resampling to smaller gridsize effect around diagonallines and curves.This problem is solved by Bilenear Interplation.Its Result are smoother,accurate,without "stairstepped" effect. But it has some disadvantage that is edges are smoothed and some extremes of the data file valuesare lost. The most accurate resampling method is cubic convolution. It gives the effect of cubiccurve weighting can sharpen the image and smoothout noise. But the disadvantage is most computational is needed and it does n't provide desired result.

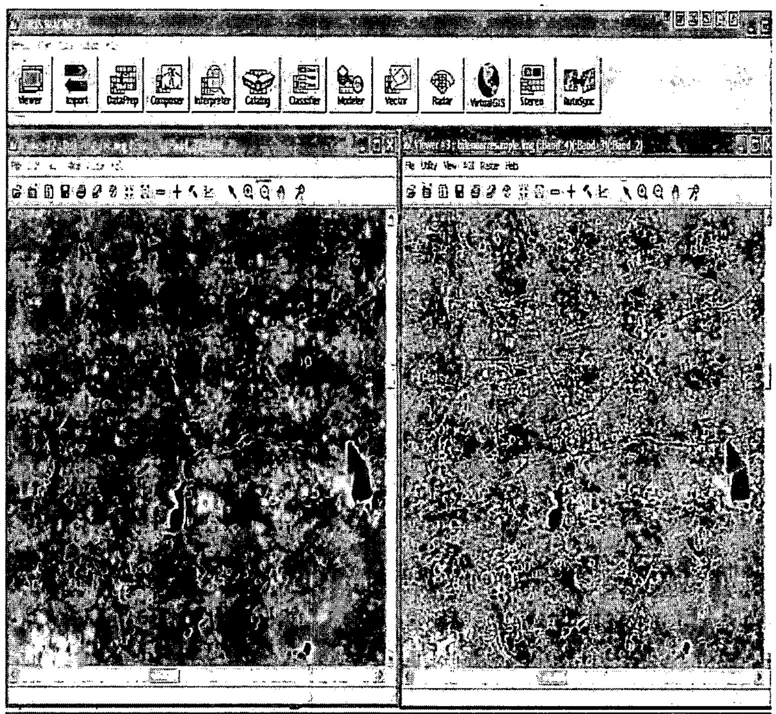

Figure 5.Result of nearest neighbor and Bilinear Interplation

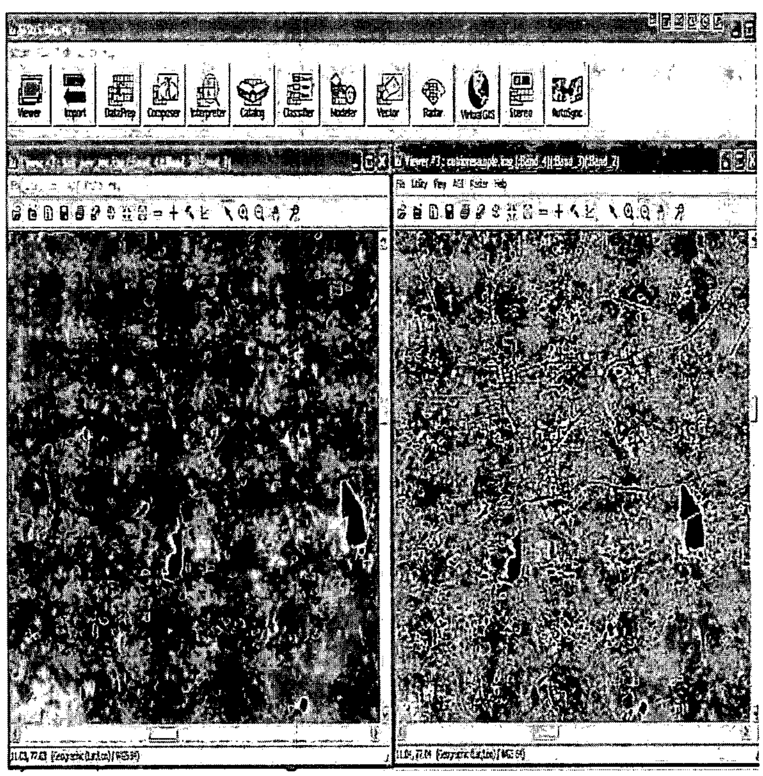

Figure 5.1.Result Bilinear Interpolation and Cubic Convolution

VI. CONCLUSION

The three resampling methods; Nearest Neighbor, Bilinear Interpolation and Cubic Convolution, determine how the cell values of an output raster are determined after a geometric operation is done. The method used depends upon the input data and its use after the operation is performed. Nearest Neighbor is best used for categorical data like land-use classification or slope classification. The values that go into the grid stay exactly the same, a 2 comes out as a 2 and 99 comes out as 99. The value of of the output cell is determined by the nearest cell center on the input grid. Nearest Neighbor can be used on Continuous data but the results can be blocky.Bilinear Interpolation uses a weighted average of the four nearest cell centers. The closer an input cell center is to the output cell center, the higher the influence of its value is on the output cell value. This means that the output value could be different than the nearest input, but is always within the same range of values as the input. Since the values can change, Bilinear is not recommended for categorical data. Instead, it should be used for continuous data like elevation and raw slope values. Cubic Convolution looks at the 16 nearest cell centers to the output and fits a smooth curve through the points to find the value. Not only does this change the values of the input but it could also cause the output value to be outside of the range of input values (imagine a sink or a peak occurring on a surface). This method is also not recommended for categorical data, but does an excellent job of smoothing continuous data.

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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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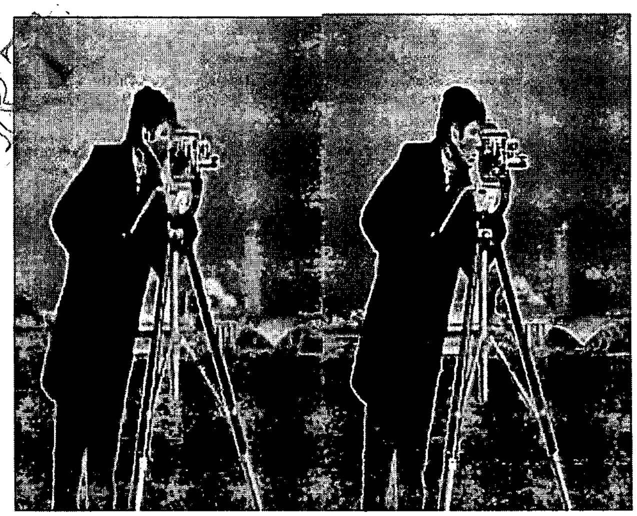
Abstract – **Satellite images are used in many applications such as agriculture, geology, forestry, landscape, regional planning, education, biodiversity conservation and warfare. Satellite imagery is also used in oceanography in deducing changes to land formation, water depth and sea bed, by color caused 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

ISSN: 2278-0181
Vol. 2 Issue 6, June - 2013

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.

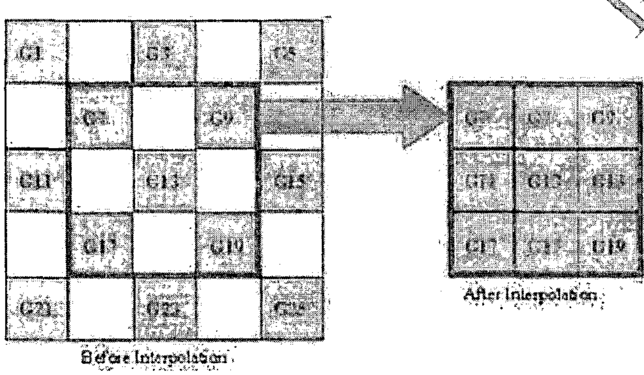


Fig.2.The interpolated points and its intensity range

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).

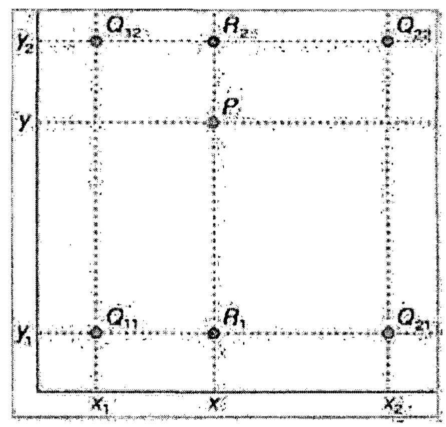


Fig.3. Bilinear Interpolation

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

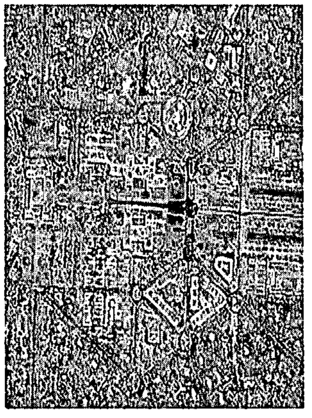
Bicubic interpolation is often chosen over bilinear interpolation or nearest neighbour in image resembling, when speed is not an issue. Because it provide a less interpolation distortion.

Disadvantages

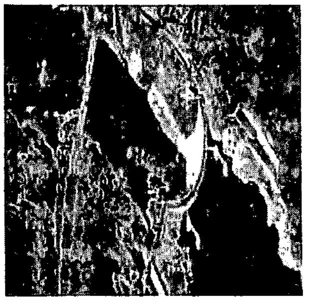
Complex calculation compared to other two method described above. Greater time need to generate the output compared to bilinear and nearest neighbor methods.

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.

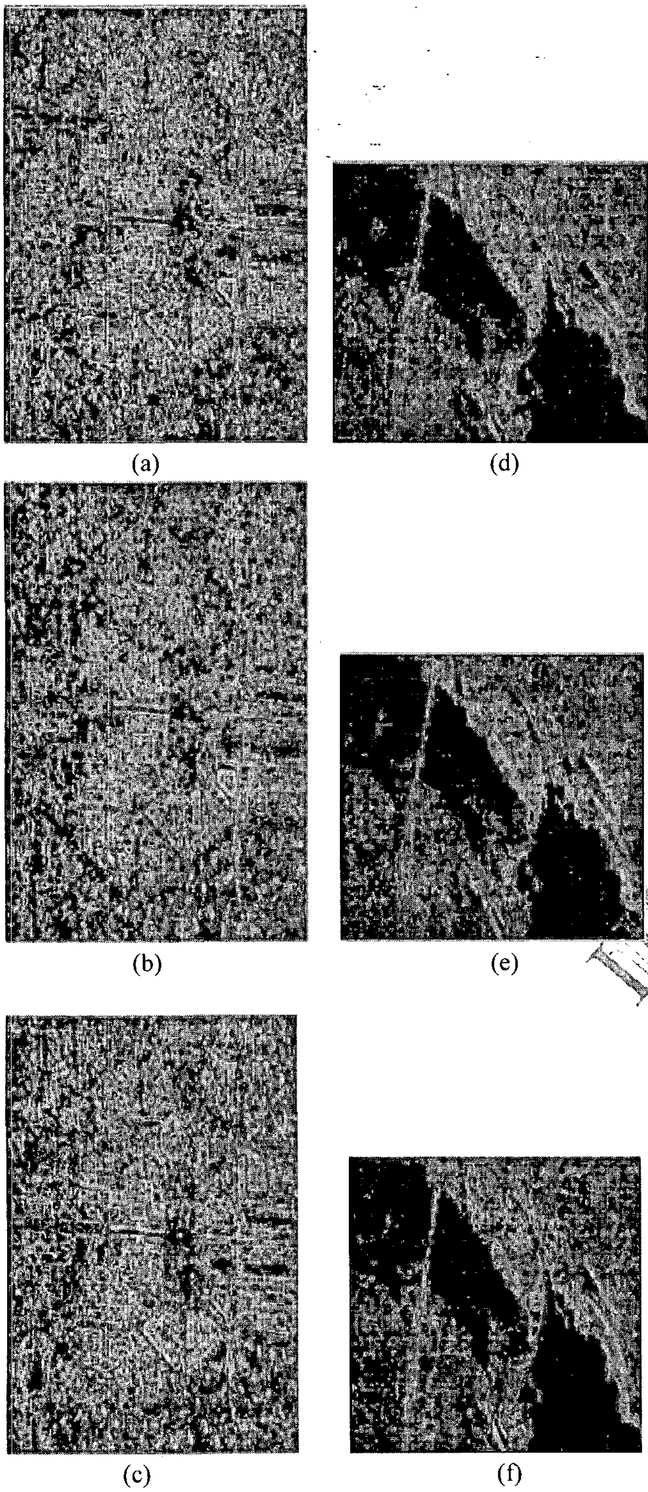


Fig. 5.Out Put Image After (a) & (d) nearest neighbor (b) & (e) bilinear (c) & (f) Bicubic - interpolation

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.

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