Volume 6, Issue 10, October 2016 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Vectorization of Satellite Images based on Interpolation Techniques

Assist. Prof. Dr. Rehab F. Hassan, Lubna Mohammed

Department of Computer Science, University of Technology,

Baghdad, Iraq

Abstract: Geographic information is effective decision making for building disaster planning, crisis management and warning systems. Most of Geographic Information Systems (GIS) applications are satellite images, which are often hard to interpret. The main aim of this paper is to implement satellite vectorization system has the ability to providing a solution, which is often easier to interpret process of zooming with keeping a high resolution of satellite images based on specify interpolation methods: 'cubic', or 'spline' . Also it reduce time task, which requires the presence of the human operator and amount of work.

Keywords: vectorization, satellite images, interpolation, Spline, zooming

I. INTRODUCTION

There is a contradiction between rapidly increasing spatial data amount and limited network bandwidth. Raster and vector are the two basic data structures for storing and manipulating images and graphics data on a computer. These are very important in modelling and simulation applications in GIS. A raster data is depicted as rows and columns of cells with each cell having a single value and also called bitmap images, and consist of a grid of individual pixels where each pixel can be of a different colour or a shade. A vector data has its shape represented using geometry which use mathematical relationships between points and connection paths. The geometry is made up of one or more interconnected vertices [1].

II. RASTER AND VECTOR REPRESENTATIONS

Raster and vector representations form the foundation upon which nearly all two-dimensional graphics is built. Raster images can represent extremely rich detail but do not encode the kind of semantic information that promotes editing. Vector images, on the other hand, abstract image content as mathematical primitives such as lines and arcs that facilitate editing but can limit detail. While converting from a vector to a raster representation is a straightforward sampling operation, the complementary procedure of vectorization is significantly more difficult since it involves inferring high-level abstractions from low-level pixel content [2]. Raster-to-vector conversion in GIS of remote sensing image is a very important task for extract and updating linear cartographic objects in cartographic processes [3]. Using vector representations of raster images in spatial queries gives more accurate results, lower computation costs and better response times [4].

III. DIGITAL IMAGE INTERPOLATION [5]

Image interpolation occurs in all digital photos. It happens anytime you resize your image or distort from one pixel grid to another. This paper focus on Image resizing can be shown in figure (1) which is necessary when you need to increase or decrease the total number of pixels

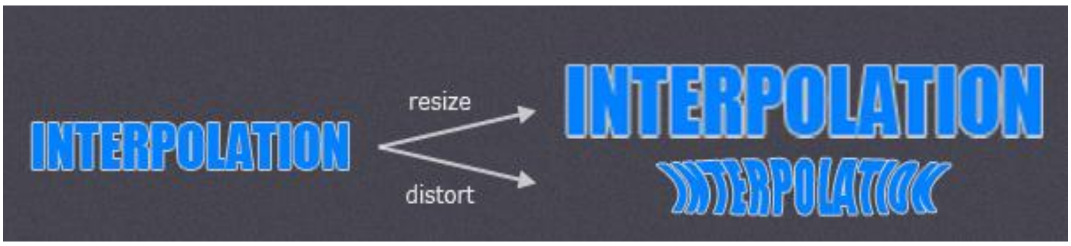


Figure (1): Example of Interpolation

Interpolation works by using known data to estimate values at unknown points. Image interpolation works in two directions, and tries to achieve a best approximation of a pixel's colour and intensity based on the values at surrounding pixels. Figure (2) illustrates how resizing / enlargement works:

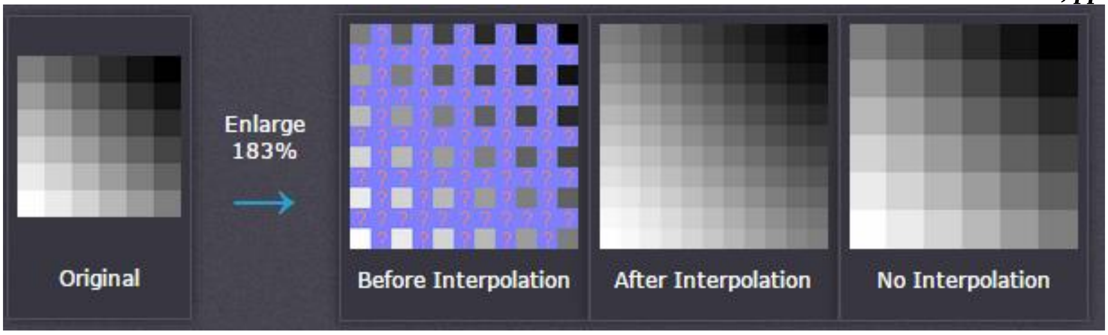


Figure (2): Example of Image Resize Example

Interpolation is the process of determining the values of a function at positions lying between its samples. It achieves this process by fitting a continuous function through the discrete input samples. Several interpolation techniques have been developed. The most commonly used methods are cubic, spline interpolation techniques. Less common are the polynomial and Lagrange interpolation methods. The numerical accuracy and computational cost of interpolation algorithms are directly tied to the interpolation kernel. As a result, interpolation kernels are the target of design and analysis [6, 7].

Cubic interpolation [6, 8] is interpolation algorithm that fairly well approximates the theoretically optimum since interpolation function. The kernel is composed of piecewise cubic polynomials defined on subintervals (-2, -1), (-1, 0), (0, 1) and (1, 2). Outside this interval the interpolation kernel is zero. For deriving the cubic convolution kernel, we have to solve 8 linear equations with 7 unknown parameters, so the system has one "free" parameter that may be controlled by the user. The kernel is of form:

$$h(x) = \begin{cases} (a+2)|x|^3 - (a+3)|x|^2 + 1 & 0 \le |x| < 1 \\ a|x|^3 - 5a|x|^2 + 8a|x| - 4a & 1 \le |x| < 2 \\ 0 & 2 \le |x| \end{cases}$$

The frequency response is

$$R(\omega) = \frac{12}{\omega^2}\left(\sin c^2\left(\frac{\omega}{2}\right) - \sin c(\omega)\right) + a\frac{8}{\omega^2}\left(3\sin c^2(\omega) - 2\sin c(\omega) - \sin c(2\omega)\right)$$

Choices for a are a=-1, a=-0.75 and a=-0.5. The performance of the interpolation kernel depends on a, and the frequency content of the image. For different images, different values of the parameter a gives the best performance.

Splines [9]

A spline of degree n is derived through n convolutions of the box filter, B 0 . Thus, B 1 =B 0 *B 0 denotes a spline of degree 1, let us consider an image F(h,v) at 2D interval (h=hk+x. T,V=V1+Y.T) where 0<= x,y<=1 The spline interpolation kernel is defined as:

$$f(x,y) = \frac{1}{6T}\{\tilde{f}_{l-1}(x)\left[(3+y)^3 - 4(2+y)^3 + 6(1+y)^3 - 4y^3\right] + \tilde{f}_l(x)\cdot\left[(2+y)^3 - 4(1+y)^3 + 6y^3\right] + + \tilde{f}_{l+1}(x)\left[(1+y)^3 - 4y^3\right] + \tilde{f}_{l+2}(x)\cdot y^3\}$$

where $f_j(x) = \frac{1}{6T}\sum_{i=0}^{3} b_{ij}\cdot x^{3-i}, \quad j = l-1, l+1, l+2,$

Proposed system

The phase structure of the proposed system is consists of stages. Each stage has specific functions, all the functions are explained in detail in the following subsections. Figure (3)

Satellite images

The data set (Satellite images) used in this paper were taken from IKONOS Satellite Image of Denver, Colorado collect and downlink with Limitations on transmission time, and display resolution may restrict the amount of data used to represent an image. These issues affect image processing and storage on-board the satellite.

Transformation

Satellite images are difficult to explain, and it have problem affect in preparation of the image for transmission and Satellite images storage. So, it may be addressed by data compression techniques by using wavelet transform with Haar filter .The main objective of this transform is to enhance and suppress the undesired distortion of Satellite images by produced LL, LH, HL, and HH. The LL image is considered a reduced version of the original as it retains most details.

Region of interest (ROI)

ROI is fundamental stage in Satellite images analysis based on expert user that means the selected area of Satellite images chosen by user. This area need to enter to Raster-to-vector conversion to have a clear sense for experiment.

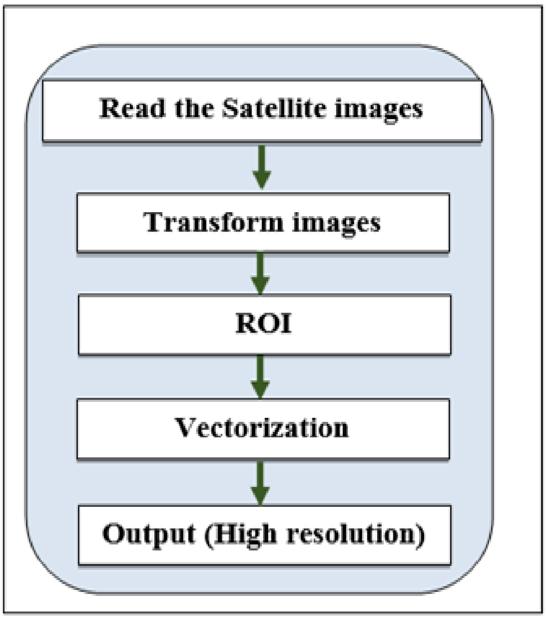


Figure (3): Phase structure of proposed system stages

Vectorization of Satellite images

Vectorization of Satellite images is basic stage, which it is presented as heart of proposed system based on interpolation methods. The basic algorithm which it can be shown in following algorithm used for Vectorization defined by mathematical relationships between points and the paths connecting them to describe an image

Algorithm: Vectorization based on interpolation
Input: N data points P(x i ,y i), N≥4. Output: set of interpolated points INTRP(x i ,y i).
Step1: Define parameters: 1.1 Define the A[N-2][N-2], B[N-2], X[N-2] .... For holding the (AX=B) system. 1.2 Define the coefficients vectors a[N-1], b[N-1], c[N-1], d[N-1] 1.3 Define h[N-1] Step2: Initialize parameters: 2.1 Initialize h vector. 2.2 Initialize 'A' matrix from h vector 2.3 Initialize B vector from the right side of equation $\begin{bmatrix} 1 & 4 & 1 & 0 & \cdots & 0 & 0 & 0 & 0 \\ 0 & 1 & 4 & 1 & \cdots & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 4 & \cdots & 0 & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & \cdots & 4 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 1 & 4 & 1 & 0 \\ 0 & 0 & 0 & 0 & \cdots & 0 & 1 & 4 & 1 \end{bmatrix} * \begin{bmatrix} M_2 \\ M_3 \\ M_4 \\ \vdots \\ M_{n-3} \\ M_{n-3} \\ M_{n-1} \end{bmatrix} = \frac{6}{h^2} * \begin{bmatrix} y_1 - 2y_2 + y_3 \\ y_2 - 2y_3 + y_4 \\ y_3 - 2y_4 + y_5 \\ \vdots \\ y_{n-4} - 2y_{n-3} + y_{n-2} \\ y_{n-3} - 2y_{n-2} + y_{n-1} \\ y_{n-2} - 2y_{n-1} + y_n \end{bmatrix}$ Step3: Solve the AX=B: Using LU Decomposition to solve the system and store the results in X[] vector Step4: Build the vector M[N] , from which the coefficients values will be computed Step5: Calculate the coefficients' values Step6: Return the INTRP(x i ,y i) points

Performance Measures of the Proposed System

This section illustrates the results of zooming the Satellite images by describing the experimental results for both traditional zooming technique (first order, convolution) and Vectorization of Satellite images proposed System. The performance of the proposed system has been obtained from the testing by Satellite images by different size of zooming which it can be shown in Table (1). The first row with normal (N) size .The second row with 5% zooming and so on. Also, histogram based features(Variance, Entropy, Skewness) compared for all satellite images which it can be shown in Table (2) .the result in this table explain smoothness of satellite images based on traditional and interpolation

Table 1: Number of cases tested.

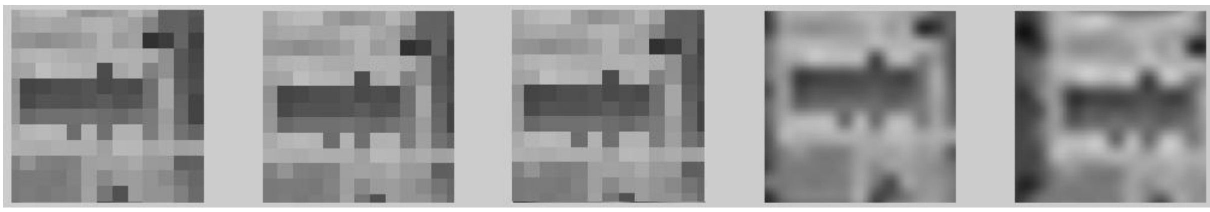
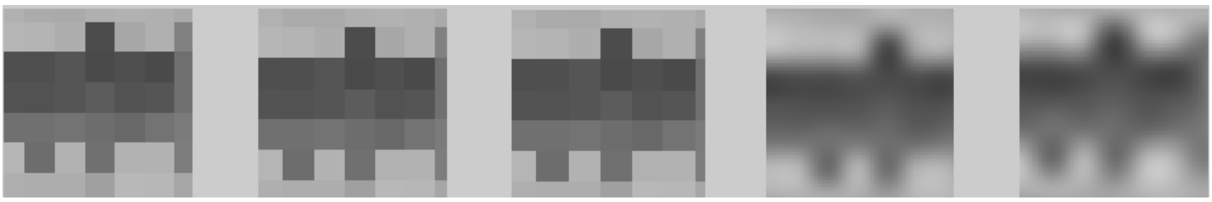
size	**Original**	**proposed System**	**First order and convolution**
N			
5%			
10%			
15%			
20%			

Table 2: histogram based features

size	First order	convolution	**proposed System** (Cubic and Spline)	
Variance	1.3487	1.3643	1.7214	1.7929
Entropy	1.5458	1.5525	1.6121	1.6726
Skewness	0.3118	0.3243	0.3657	0.3941

IV. CONCLUSIONS

During scientific study and GIS applications, noticing that not all satellite images has a high resolution when zooming ROI of user selected regions. The better result has obtained when used Vectorization of Satellite images (cubic, spline). Specially, when increase the size of zooming to 10% and 15% the result of traditional zooming technique (first order, convolution) may be worst. In addition, histogram based features shows that variance, entropy and Skewness of Vectorization of Satellite images (cubic, spline) is better too. Satellite vectorization system has the ability to providing a solution, which is often easier to interpret process of zooming with keeping a high resolution of satellite images

REFERENCES

[1] Suleyman, E. & Ahmet, S., "Performance Evaluations of Vector-Raster Satellite Image Transfers through Web Services", IEEE 36th International Conference on Computer Software and Applications, Turkey, 2012.

[2] Noris, G., Hornung, A., Sumner, R. W., Simmons, M., and Gross, M.. "Topology-Driven Vectorization of Clean Line Drawings". Zurich, 2013.

[3] Mohamed Naouai, Melki Narjess1 and Atef Hamouda1, "Line Extraction Algorithm Based on Image Vectorization", Proceedings of the IEEE International Conference on Mechatronics and Automation, china, 2010.

[4] Süleyman, E. & Ahmet, S., "An Automated Technique to Determine Spatial-Temporal Changes in Satellite Island Images with Vectorization and Spatial Queries", Indian Academy of Sciences, Turkey, 2015.
[5] http://www.cambridgeincolour.com/tutorials/image-interpolation.htmL
[6] Póth, M., "Image Interpolation Techniques", Serbia and Montenegro, 2004
[7] George Wolberg. Digital Image Warping. IEEE Computer Society Press, Los Alamitos CA, USA, 1994.
[8] Evgin, G.," Interpolation approaches and spline based resampling for MR images", IEEE, Health Informatics and Bioinformatics (HIBIT), 2010.
[9] Mihalk, J.& Josef, Z, "Spline Interpolation Of Image", Park komeenskeho,1995

