Social disaster evaluation model based on submerge GIS and DEM

Hongbiao Xie

*Hangzhou Dianzi University Information Engineering School,
Hangzhou 310018, Zhejiang, China*

Abstract
According to the accuracy of submerge DEM algorithm is low in disaster evaluation of high resolution GIS images, this paper proposes a flood evaluation model based on optimization of hybrid wavelet transform threshold DEM. First, we introduce wavelet transform algorithm, and discretize the variables of the transform domain, to eliminate the redundant transform. And then we design a kind of program with balance between soft and hard threshold, add adaptive threshold factor in estimator, and the standard threshold of wavelet transform algorithm is optimized. Finally, we make the energy of the original submerge DEM flood algorithm focus on the high frequency coefficient of the greater threshold value covered within the scope, so that can maximum extract the local characteristics in the spatial domain within the scope of frequency domain. Simulation experiments show that compared with the standard submerge DEM algorithm, the proposed flood evaluation model based on optimization of hybrid wavelet transform threshold submerge DEM has the higher accuracy is in disaster assessment of the high resolution of image GIS.
Key words: SUBMERGE DEM, IMAGE GIS, G-C TRANSFORM, DISASTER EVALUATION, MIXED THRESHOLD, WAVELET TRANSFORM

Introduction

Flood disaster risk analysis and evaluation are an important part of flood management, its role is based on the comprehensive evaluation of flood disaster risk, and prepares disaster risk distribution of different spatial scales in the condition of that human can't control natural disasters and even can't be completely accurate forecasting or early warning. And it can identify the high risk area, provide more effective disaster prevention and preparedness services for governments at all levels; at the same time it can also give effective early warning for floods, which can provide more explicit disaster and disaster relief work for people [1].

At home and abroad since the early 1980 s, started to explore a variety of risk factors of flood risk analysis method and practice research, and put forward based on the joint probability method, variable structure method and simulation technology such as multivariate extreme value theory, and different scholars do explore aimed at the problems in application. For example, Jonathan makes the expression of regional rainfall for the linear combination of the precipitation station precipitation, to meet the precondition of application of variable structure [2]. To solve the problem of the distribution of the hydrological variables standard Gumbd, Zhu Yuan proposes two-dimensional compound event risk portfolio model, which is used to analyze the flood risk of south-to-north water transfer project. Combine flood hydrology risk with the project risk of flood control facilities, Zhu Yonghua put forward Binary values Poisson point process model with the size of the flood and duration for the values, and gives an equation of comprehensive flood control risk rate [3]. Feng Ping et al. research multivariable flood control calculation under the action of the storm floods [4]. Combined with the problems of south-to-north water transfer project, Jia Chao and others are analyze the application of the theory of system for reliability of hydraulic structure, the flood risk, geological disaster risk, and overall system risk [5]. Chen Jin research the composition of the watershed flood control engineering system, influence factors and risk analysis method [6]. Steding J.R and Taylor M.R. study on parameters of random annual runoff model and found that: even collect 50 years of traffic information, the influence of the uncertainty of parameters is also very big; After discussed the specific design flood risk problem: in small sample situation, determine in a traditional method of design flood in 100 such as the maximum likelihood method and moment method will make a design on the low side, but if in the case of hydrological information is sufficient, using Bayesian method and statistical method, can avoid the problem [7]. Kuczera G study the relationship between hydrological time series and the reliability of parameter estimation, and presents two improved the reliability of parameter estimation methods: one is to use one or two moments estimation and correction; The second is to use function and groundwater, soil water reserves the corresponding time series data [8]. Diaz Granados - such as M.A. and Valdes J.B is studied the influence of rainfall intensity and soil moisture on flood risk [9]. To short-term flood risk prediction problem, Futter M.R. and Mawdsley J.A. are compare the COX regression model and model assumes of the conditional distribution model, the required data and accuracy problems [10]. Anselmo V.Galeati G et al. use hydrological and hydraulic affinity model to a flood prone in Italy to flood risk assessment [11]. Sen. Z calculates the linear correlation of the level of risk value by Markov process [12].

According to the defects of the flood submerge evaluation model based on DEM, this paper proposes a flood submerge evaluation model based on improved hybrid threshold wavelet transform optimization DEM.

Flood Submerge Evaluation Model Based on DEM

DEM is expressed in Numbers in the form of ups and downs of the terrain, and it expresses terrain special points with 3D coordinate data and describe the algorithm of terrain as the core, common DEM data is consist of the corresponding points on the terrain of xy and their corresponding point elevation value, function is expressed as equation (1).

$$V_i = (X_i, Y_i, Z_i) \qquad (1)$$

In the equation (1), X_i and Y_i are plane coordinates in a two-dimensional coordinate, Z_i is the elevation values corresponding to plane coordinates, when DEM expressed as a regular grid, plane coordinates in function can be omitted, and DEM data is simplified to only have a one-dimensional sequence of elevation values.

Digital elevation model of discrete points is disperse continuous form of the earth's surface into elevation point Z_i storage on X_i, Y_i, Z_i 3D coordinates of a particular area D, $(X_i, Y_i) \in D$ is the plane coordinates, Z_i for corresponding elevation of the plane coordinate.

Before weighted adjacency matrix is used to establish contour tree structure, we must determine the different depth of adjacent, contains the relationship between the contours. Therefore, first we must give the only label to each contour line segment on bathymetric map, easy to recognize the contour line when search adjacency matrix. Figure 1 is marking bathymetric map after morphology operations. Direct by the original bathymetric map to judge the adjacent containment relationship between each line algorithm is very complicated, so we can make the original bathymetric map expansion according to the equation (2):

$$X \oplus S = \{(x, y) \mid (x, y) = (a_x, a_y) + (s_x, s_y)\} \qquad (2)$$

In the equation, X is coordinates vector set of bathymetric binary image pixel, S is coordinates vector set of structure elements, and respectively have their own scope as shown in the following equations.

$$(a_x, a_y) \in X \qquad (3)$$

$$(s_x, s_y) \in S \qquad (4)$$

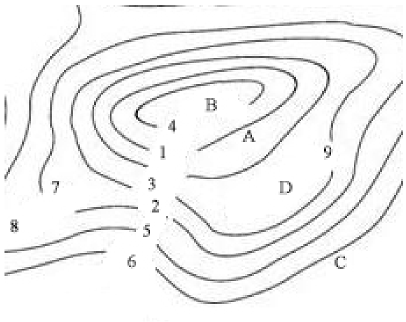

Figure 1. Marked bathymetric map

The adjacent of two line segments in images namely judgment adjacency between pixels in the segments, and judgment method of adjacency between pixels with 4 - field, diagonal field, 8 - field. Using 8 - field to determine of adjacent relation between the depth contours, so progressive scan the expansion image. Detect all have different label but adjacent pixels in 8 field, and add up the numbers of pixels of the adjacent label, as the weight of adjacent relation, to mark as w_{ij} . The size of w_{ij} represents the adjacent degree between the contour lines i and j. The greater the value is, the greater the father-son relationship of two line segments. The length of the line segment is represented using its line cover sizes in images, so for the length of the line j segment can be expressed as $l_j = N_j$, N_j is the numbers of the pixels of line j in the image, and due to W_{ij} as the number of adjacent pixels of line j and line i, so when $W_{ij} \geq l_j$, line i is the parent node of line j. Then weights by search and the serial number of the contour compose the weighted adjacency matrix. Weighted adjacency matrix contains the entire adjacent segment, the adjacent segment of adjacency information such as length and the length of the line itself.

Weighted adjacency matrix is the adjacent relationship between contour reaction, does not contain the contour from shallow to deep relationship have to sexual expression comes out, so the weighted adjacency matrix is a weighted undirected graph. According to the weighted adjacency matrix based contour tree weighted adjacency matrix should be according to the following process in order to search.

Suppose equation (5) as weighted adjacency matrix, w_{ij} is the weight of line i and line j, l_j is the length of line j.

$$A = \begin{pmatrix} w_{11} & w_{12} & \dots & w_{1n} \\ w_{21} & w_{22} & \dots & w_{2n} \\ \dots & \dots & \dots & \dots \\ w_{n1} & w_{n2} & \dots & w_{nn} \end{pmatrix} \quad (5)$$

The marked number $1...n$ arranged according to row and column order of A , due to record visited line label, so the collection can be defined as $X = \{x_1, ..., x_n\}$, x_i as the record number of line i for label not access line node, $Y = \{y_1, ..., y_j\}$ and y_j is the line nodes with accessed, when determining the line node of the m layer, set Y can be empty and established the m layer of segment nodes to join in the collection Y. However, because the GIS remote sensing image is generally for high resolution image, the discrete element method (DEM) modeling for the GIS remote sensing image and the standard model also has the low accuracy.

DEM Model Based on Wavelet Transform Optimization

Express or transform for continuous measure of DEM data, conventional methods are nearby, bilinear, double three interpolation methods, but these methods lack the inverse process is simple and practical, can't convert between various resolutions, in the same area of different resolution DEM should be rebuilt. Wavelet transform reconstruction process is the inverse process of its transformation process. Refactoring process is basically the same with the process of decomposition, can not only fully realized, and decomposition process is also concise and efficient; better make up for the defects.

Wavelet Transforms Threshold Optimization

As the continuous wavelet transform is redundant, so it is necessary to make clear, to reconstruct the signal, it needs to discretize variables of transform domain,

With the advancement in networking and multimedia technologies enables the distribution and sharing of multimedia content widely. To eliminate the redundancy of transformation, in practice, often take $b = \frac{k}{2^j}$, $a = \frac{1}{2^j}$, $j,k \in Z$, while,

$$\psi_{a,b}(t) = \psi_{\frac{1}{2^j},\frac{k}{2^j}}(t) = 2^{j/2}\psi(2^j t - k) \quad (6)$$

Abbreviated to $\psi_{j,k}(t)$.

The form of transformation is shown in equation (7).

$$WT_f\left(\frac{1}{2^j}, \frac{k}{2^j}\right) = \left\langle f, \psi_{j,k} \right\rangle \quad (7)$$

In order to reconstruct the signal $f(t)$, require $\{\psi_{j,k}\}_{j,k\in z}$ is the Riesz base of $L^2(R)$.

A function $\psi \in L^2(R)$ called as a R function, if $\{\psi_{j,k}\}_{j,k\in z}$ is a Riesz base under the following sense: linear expansion of $\{\psi_{j,k}\}_{j,k\in z}$ is dense of $L^2(R)$, and exist positive constant A and B, $0 < A \le B < \infty$, and

$$A\|\{c_{j,k}\}\|_{l^2}^2 \le \|\sum_{j\in-\infty}^{\infty}\sum_{k\in-\infty}^{\infty} c_{j,k}\psi_{j,k}\|_2^2 \le B\|\{c_{j,k}\}\|_{l^2}^2 \quad (8)$$

The sequence $\{c_{j,k}\}$ can set up for all double infinite squares, namely $\{c_{j,k}\}$ is established for $\|\{c_{j,k}\}\|_{l^2}^2 = \sum_{j\in-\infty}^{\infty}\sum_{k\in-\infty}^{\infty}|c_{j,k}|^2 < \infty$.

Suppose that ψ is a R function, then there is a only Riesz base $\{\psi^{j,k}\}_{j,k\in z}$ of $L^2(R)$, its meaning is shown in following equation (9).

$$\left\langle \psi_{j,k}, \psi^{l,m} \right\rangle = \delta_{j,l}\delta_{k,m},\ j,k,l,m \in Z \quad (9)$$

The equation is dual representation with $\{\psi_{j,k}\}$. Here, each $f(t) \in L^2(R)$ has only series expression,

$$f(t) = \sum_{j=-\infty}^{\infty}\sum_{k=-\infty}^{\infty}\left\langle f, \psi_{j,k}\right\rangle \psi^{j,k}(t) \quad (10)$$

Specially, if $\{\psi_{j,k}\}_{j,k\in z}$ make up standard orthogonal basis of $L^2(R)$, there is $\psi_{j,k} = \psi^{j,k}$, reconstruction equation is:

$$f(t) = \sum_{j=-\infty}^{\infty}\sum_{k=-\infty}^{\infty}\left\langle f, \psi_{j,k}\right\rangle \psi_{j,k}(t) \quad (11)$$

Because of the defects of the estimated by wavelet, we design a compromise solution with soft and hard threshold, threshold of standard wavelet transform algorithm is optimized.

$$\hat{w}_{j,k} \begin{cases} sign(w_{j,k})(|w_{j,k}| - \alpha\lambda), & |w_{j,k}| \ge \lambda \\ 0, & |w_{j,k}| < \lambda \end{cases}, (0 \le \alpha \le 1) \quad (12)$$

The equation is called estimator of wavelet coefficient with soft and hard threshold compromise method. In particular, when α took the 0 and 1 respectively, the above eqaution becomes hard threshold and soft threshold estimation method. For general speaking of $0 < \alpha < 1$, the method estimates of the size of the data $\hat{w}_{j,k}$ between soft and hard method, so called the tradeoff between soft and hard threshold method.

Train of thought of this method is simple, and is very popular, but its de-noising effect is very good. Careful analysis can be found, $\hat{w}_{j,k}$ estimate by the simple soft threshold method, its absolute value smaller than $w_{j,k}$ with λ, so try to reduce the deviation: but if the deviation is reduced to zero (hard threshold) and also is not necessarily the best, because $w_{j,k}$ itself is composed by $u_{j,k}$ and $v_{j,k}$, and it may be $|w_{j,k}| > |u_{j,k}|$ due to the influence of $v_{j,k}$ (for most of the $w_{j,k}$), and our aim is to make the $\|\hat{w}_{j,k} - u_{j,k}\|$ minimum, therefore, makes the value of $|\hat{w}_{j,k}|$ between $|w_{j,k}| - \lambda$ and $|w_{j,k}|$ may lead to estimate the wavelet coefficients $\hat{w}_{j,k}$ more close to $u_{j,k}$. Based on this thought, α factor joined in the threshold estimator, the size of the α appropriate adjustments between 0 and 1, can get better de-noising effect. The experiment n this paper is $\alpha = 0.5$.

DEM Model Based on Improved Wavelet Transform

The frequency range of threshold should be set with retained in accordance with the scope respectively. Threshold processing make the scope of energy to focus on this range is greater than the threshold value of high frequency coefficient, so that they can extract the maximum frequency domain within the scope of the local characteristics in the spatial domain. Target DEM (the range of frequency domain should keep energy) for:

E_{G_A}: Target DEM frequency range A should retain the energy, the following is similar. E_{G_A} has little contribution energy for the original DEM , as $1-T$. For target DEM mainly include low frequency information, can be reduced to zero.

E_{G_B}: for target DEM, the contributions energy before frequency of f_{G_eff} should reach the threshold T, so it has equation (13),

$$\frac{E_{G\_B}}{E_{G\_A} + E_{G\_B} + E_{G\_C} + E_{G\_D}} = 1 - T \quad (13)$$

E_{G_D}: Energy should remain the same in the scope, namely $E_{G\_D} = E_{O\_D}$. E_{O_D} is the energy of original DEM frequency range D, the following similar.

Its Setting purpose is to avoid target DEM energy in frequency domain with the steep drop, so the change of the energy loss in the scope B, C and D should have a smooth trend, and is nonlinear. By experiment, it is set to the geometric sequence. $E_{G\_D}/E_{O\_D} = 1$, if $E_{G\_B}/E_{O\_B} = K$, then $E_{G\_C}/E_{O\_C} = \sqrt{K}$. So there is,

$$E_{G\_B}/E_{O\_B} = \sqrt{E_{G\_C}/E_{O\_C}} \quad (14)$$

In the frequency domain decomposition and then extract the needed range of frequency domain, only E_{G_B} and E_{G_C} are the unknown variables in the equation (13) and (14). Set up by the two type of equations can be calculated, and finally calculate the target DEM in each frequency range should be retained by the energy.

By the known, with the aid of score a binary wavelet transform, this section of synthesis method can be realized.

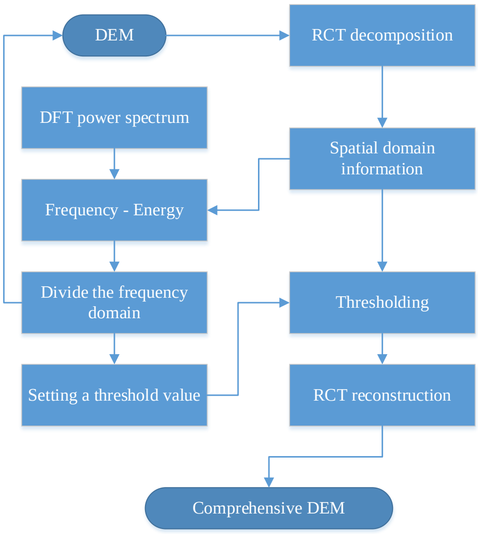

Figure 2. DEM model based on wavelet transform process improvement

As shown in figure 2, the method by the original DEM starting is divided into two layers of processing. The upper process for the analysis of the original DEM, provides a certain lower process link the required input parameters; The lower process as the goal and the implementation process of DEM, the key link need input parameter is calculated by the above process. DEM target is obtained finally.

The Algorithm Simulation

To verify the effectiveness of the improved algorithm proposed in this paper, simulation experiments on it. GIS by 2 high resolution 3 d image as an example, using standard DEM flood analysis algorithm and the improved DEM flood analysis algorithm for disaster evaluation, and compared with the actual situation, the result is as follows:

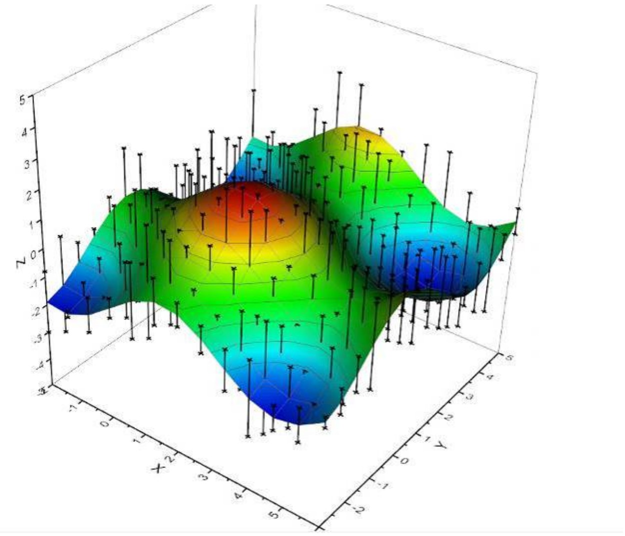

Figure 3. High-resolution three-dimensional image on the 1st GIS

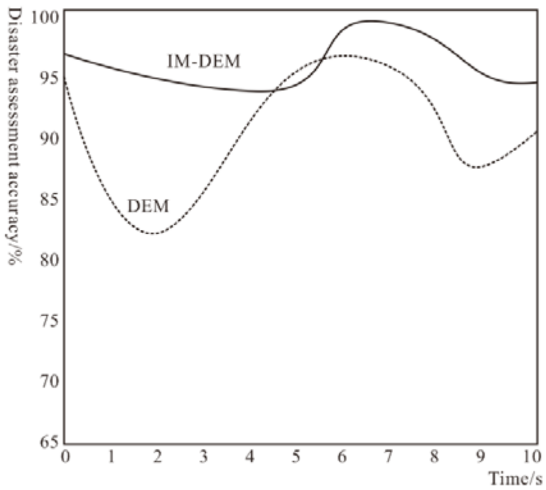

Figure 4. Compare results of disaster assessment

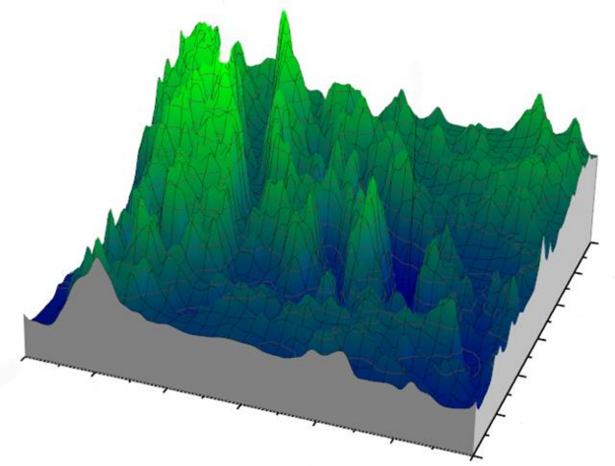

Figure 5. High-resolution three-dimensional images on the 2nd GIS

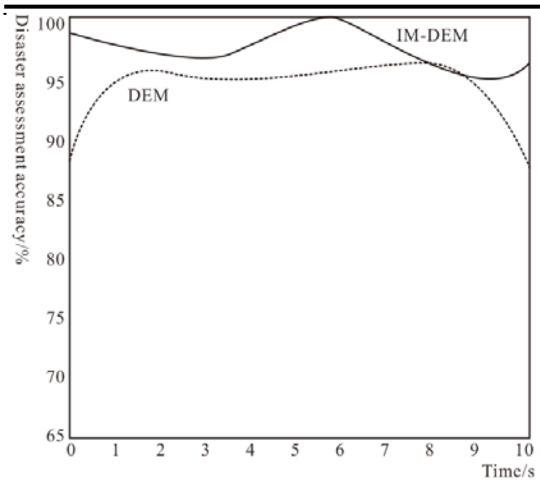

Figure 6. Compare results of disaster assessment

As it is seen from the simulation results, this paper puts forward the improvement of DEM flood analysis model in GIS 3-D image 2 disaster assessment, all show better performance.

Conclusions

The flood disaster is one of severe natural disasters to human's safety and health. Since the 20th century, the natural variation of the system is given priority to with global warming and human economic and social activities is given priority to with the urbanization of modern, the natural disaster system, especially in the flood disasters caused great influence. Although mankind has entered the information age, had the very big development of science and technology, and the construction of flood control system is increasingly perfect, but still happen, flooding or even worse. According to the defects of the flood evaluation model based on DEM, we propose a flood evaluation model based on improved hybrid threshold wavelet transform optimization DEM. The simulation results show that the proposed algorithm has better accuracy assessment.

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