Advanced Development in ARIES-Ⅲ Image Analysis Softwares and ist Application in Remote Sensing Geology

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The Dipix (ARIES-III) image analysis system is an update equipment, which is friendly and powerful, but there is some deficiency in its software package. At this time, with the development of remote sensing geology some new techniques for analysis digital image are required. Therefore, the advanced development for the Dipix System software has been proved very useful and fruitful.

Ⅰ. The Advanced Development in the software Package

There are seventeen programs added into the system. some of them are introduced as follow;

1) CCT Tapes Input/output

Because there are various kinds of CCT Tapes data which formats are not the same and the initial Program of input/outpat in the ARIES-III Software cann't meet the needs. To slove this problem, some applicated programs have been developed.

BM program: It can be used to compress modules that can't, load TM data material in CCT Tape before, and can also be used to restore in dish, operation simple, it needs only about ten minutes for a map of TM data material to be processed.

TE Program: In cct Tapes the program records only efficient image data, a record/1 Line, a dish file corresponds a tape file. The Tape material output in this program may annex with other systems.

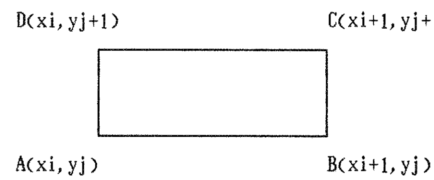
RP Program: This program reads CCT tapes with EROS Format but without head file.

RM and RN programs: They are used to read 1 Line/1 Record and 4 Lines/1 Record TM tapes respectively.

2) Digital image curve surface matching what ARIES-Ⅲ Image Analysis system processes and research is digital image. Various geological materials (mainly are data materials) must be changed into forms of digital image, all these are foundations for processing image compound and comprehensive analysis. For this aim, two problems must be sloved, one is gray Level transformation, the initial data are transposed into 0—255 and integered by usimg a simple Linear formula, the other is curve surface matching, by interpolation divitigence data spreaded on the plane matching a smooth curve surface to restor approximately space types of initial data model.

According to data spreaded on x—y plane in rectangle network, smooth curve surface are gained by whole data points. The method is using bi—cubic curve surface of x and y within every small rectangle grid and then "mosaics" these small curve surface to gain one whole curve surface.

Researching any small rectangle ABCD in rectangle network and making one bi—cubic multinomial curve surface



$$Z = b1x^3y^3 + b2x^2y^3 + b3xy^3 + b4y^3 + b5x^3y^2 + b6x^2y^2 + b7xy^2 + b8y^2 + b9x^3y + b10x^2y + b11xy + b12y + b13x^3 + b14x^2 + b15x + b16$$

There are 16 coefficients in above equation. Appraently, if we gain 16 known conditions, then the coefficients will be made out.

To any network point A (Xi, Yj).

Z (Xi, Yj) = ZA

Known observed value, using methods of difference according to value in X vector and y vector adjoining, can gain $R_A = (\frac{\partial z}{\partial x})_A$. $S_A = (\frac{\partial z}{\partial y})_Z$ and $T_A = (\frac{\partial^2 z}{\partial x \partial y})_A$.

Using any rectangle network ABCD vertex then computing RA, SA, TA respectively; then put the known 16 conditions gained into curved surface equation, making out coefficients individudlly; otherwise, the boundary points in whole rectangle network need be adjusted because of data point deficience on boundary.

Curved surface having been made out, all data are converted into integate among 0—255, then image file are set up, the transformation fomula is

$$g(i,j) = \frac{Zij - Zmin}{Zmax - Zmin} \times 255$$

g(i, j) is gray level after converted, Zij is observed value, Zmax and Zmin are maximum and minimam respectivlly.

3) Edge Detecting

In geological translation of Remote sensing image, detecting and recalling various linear characterize is a important aspect, seeing texture of gray level, the linear characterizes are generally gray level varying unconsistently, that is to say there are some sudden change area, which are the sign of the ending in one subarea and the begining in the other subarea. In the suddenchange area, "boundaries" are formed. which are usually structure interested by us.

For outstandingthese features, "sharpen" processingtoimage is necessary, using hige-pass filter putting off obscure view and increasing high-space frequency part, making image outline clearer and raising efficient, otherwise, any other edge increasing methods may gained fruit.

According to relative material, we have designed program by using Rosenfeld and Sobel nonliner mask, combination with convolution of filter and good efficient has been reached.

There are 9 edge detecting operators and various gradient choice methods in the programs. These operators and methods may be used association freely.

A1	A2	A3
A4	A5	A6
A7	A8	A9

In above diagram, A1-A9 represents gray level value in adjoining pixel respectivly, compute formulas are as follow:

Method one, G=SQRT(X*X+Y*Y)

in which, X=A1+A2+A3-A7-A8-A9

Y=A1+A4+A7-A3-A6-A9

Method 2, G=|X|+|Y|

in which X and Y are the same as method 1.

Method 3, G=|Min(A1, A2, A3)-Max(A7, A8, A9)|

Method 4, G=|Min(A1, A4, A7)-Max(A3, A6, A9)|

Method 5, G=|A5-A1|+|A5-A3|+|A5-A9|+|A5-A7|

Method 6, G=A5-Min(A1, A2, A3, A4, A6, A7, A8, A9)

Method 7, G=SQRT(X*X+Y*Y)

in which X=A1+2A2+A3-A7-2A8-A9

Y=A1+2A4+A7-A3-2A6-A9

Method 8, G=SQRT(X*X+Y*Y)

in which X=A1+3A2+A3-A7-3A8-A9

Y=A1+3A4+A7-A3-3A6-A9

Method 9, G=Log(A5)-1/4[Log(A2)+Log(A4)+Log(A6)+Log(A8)]

The G values above are output resuts, used above formulas and output image reflected gradient change is reachd with 3×3 window, whole map is computed.

According to different application needs we may use different values and combine gradient view with initial view, then reach more increasimg results.

4) Principle Component Enhancement

Principle component analysis is a method which is usually used in multi-member statistic. By being used K-L transform, a group of initial variables are made up repeating into few principle component independent each other. So reduceing the dimension of sampling group and making quadratic deviation minimum.

Principle component analysis of initial images may be processed in the program. Every component is queued from big to small in quadratic deviation.

Ertractire former P (P≤M) prircipIe component and transform initial data produce every principle component image.

In the program, these data and values are output, which are mean value, quadratic deviation, coefficient matrix and their correlation feature value, feature vector.

5) 3-dimension Enhancement

The 3-dimension image may reflect both topography features in 2-dimension image and variable topography height, which have highly effect of depth and solidity, Now MSS and TM being used can't provide stero-photo graph pair, By Combining the DEM (Digital Elevation Model) with Remote Sensing image, we produce stereo Remote sensing image using 3-dimension stereo perspective theory.

In order to gain stereo image, we take two steps.

The first is resampling for inital image pixel in coordinate transformation formula, reaching a projection in apparent-plane, then "raise" pixel point elevation data to arbitraried place.

If body lie in A(i, j), elevation data is hij, then apparent angle of slope a projet to apparent plane's hight is he=hij · sina

In order to reach different stereo results provided hight adjust coefficient K, then he=K · hij · sina

6) Image and Graphic transform, plotting Output

This is a special program. It may transpose ARIES-III image file into file-11 vector file. The vector file may both display on graphic terminal and draw in plotting machine, it also restore into image file. It is realize for image and graph to transpose each other. User may freely use different output instrument. Main functions are introduced as follow.

RTV-Transforming image file into vector file. priniciple function is transform file in ARIES-Ⅲ System into file-11 vector file. RTV function may transpose only one time or respectively. Image may big or small. The transposed spead is quick.

VTR-Transposing vector file into image file. This function is to transpose file-11 vector file into class file in ARIES-Ⅲ system.

DRAW-Display vector file on graphic terminal, one class one time, may display individually, speed quick and audic-visual.

PG-Plotting vector file into draw machine. PG function may plot vector file into standard geological map and add longitude and latitude or UTM grids, marking connetion diagram, name, legend, scale, numbering and so on.

7) Produce longitude and latitude and UTM grids

Based on former producing grids program GG in the system, we have erlarged GL program, The GL program both may produce UTM grids in disk and can plot UTM grids in UMA with addition mark, and also can produce longitude and latitude grids annotation.

8) Image Auto-segment and video output

In the present equipment condition. The main method of image output is video-photography output, it is necessary for a lager image to be segmented into many photograph then mosaiced into a whole image. We have developed a program to furnish functions mentioned above.

II. The Application of Image Analysis Technology in Remote Sensing Geology.

By using the achievements introduced above in image analysis technology, Geological different databases have been integrated with the remote sensing image data and their geological interperting results in Southern China. In Chenzhou, Hunan, 40,000KM2 geological multi-sources digital image base has been used to mineral explore. Discovered and verified the NW/SE faults, NE/SW deep faults in southern Hunan, Chenzhou matrix checked faults, and their control deposit meaning (cross-point control deposit). At the same time, some polygon, eliipse and circle broken massifs have discovered. These special deposit models in remote sensing images are formed by main large faults cross and some of these beaked massifs with magma intrusion and thermal metamorphosed deposit are multi-gentical.

A new way by using remote sensing has been exploed to mineral forecast in plant cover area and subtopical zone area. In experiment area about 80,000 Km2, the models introduced above have been appeared and by using these models the investigation of deposits is very efficient.

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