THE PHOTOGRAMMETRY IN COAL MINE SURVEYING

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Abstract

This paper describes the applicability of photogrammetry in coal mine. Introduces author's practical activities and photogrammetry effects in coal mine. Including large scale mapping, creating control network and engineering survey. Finally, the author expects that new photogrammetry technology would be used widely in the coal mine.

1. Introduction

The surface and the feature changes more often during the exploitation of the open or underground pit. For example:

(1) The roads, pipes, buildings and facilities will be build up following the production develoment of the coal mine.

(2) The geographical feature of district will be destroied after the exploitation of the open pit, then according to the exploitation norm, the land and plant have to be recovered.

(3) In the case of underground exploitation, we mest to remove the residence which are built upper the pit.

So that the surveying work in the coal mine not only various but also frequently. The topographic surveying work in the coal mine list as following:

(1) At the exploration stage, the basic control network and 1:5000 scale mapping are needed.

(2) 1:2000 and 1:1000 scale topographic map is mostly used in the coal mine design stage.

(3) In construction stage, the surveyor must work on the 1:500 and 1:200 scale.

(4) In the production stage, the planimetric and elevation control network will re-survey periodically, which will be used for monitor the changes of the terrain surface.

(5) Above all different kinds of scale topographic maps should be revised periodically as a pre-requisite for the production management of the coal mine.

Dui to the charactristics of the variety and repeatibity in the coal mine surveying work, so that the photogrammetry becomes a efficient methods. Especially, following by technology development in camera, materials, instruments and digital aspects, the photogrammetry can almost resolve all terrain survey tasks in the coal mine. Using the digital data collected from the photo, the people can get the graphic files and digital information together, including topography, geology, hydrology, transpotation, pipes and environment etc.

2. Practivities

Recently years, the photogrammetry work has been done in the more than ten coal mine. It includs topography mapping by airphoto, engineering surveying and construction surveying by terrestrial and close range photogrammetry, the lower class control network by aerotriangulation.

2.1 In the aerophotogrammetry work, the photo-scale is selected according following formulae:

$$M_h = \pm K\sqrt{(1.66m_q)^2 + (0.7m_c)^2}$$ for the planimetric accuracy

$$M_s = \pm H/b\sqrt{(1.21m_q)^2 + (0.17m_c)^2}$$ for the elevation accuracy

In the formulae:

m_q -mean error of instrument measurement
m_c -mean error of orientation of the modele
K -the scale ratia for photo to map
H -the flight height
b -the photo base

The map accuracy has been verified by field survey. Its result as following:

AREA	PHOTO SCALE	MAP SCALE	INSTRUMENT	CALCULATE ACCURACY		VERIFIED ACCURACY	
				M_s	M_h	M_s	M_h
A	1:30000	1:5000	A10	1.30m	1.33m	1.52m	1.41m
B	1:25000	1:5000	A8	1.09	1.11	1.50	1.32
C	1:20000	1:5000	B8s	0.87	0.89	1.43	0.92
D	1:14000	1:5000	A10	0.62	0.70	0.76	0.72
E	1:12000	1:2000	A10	0.52	0.48	0.60	0.49
F	1:8000	1:2000	B8s	0.34	0.36	0.47	0.37
G	1:12000	1:1000	A10	0.52	0.48	0.50	0.46
H	1:10000	1:1000	A10	0.43	0.40	0.46	0.42
I	1:8000	1:1000	A10	0.34	0.36	0.42	0.37

The camera taken for the test area is RC10 with f_k=152mm

2.2 For terrestrial photogrammetry, 1:2000 and 1:1000 map has been made using JENA 19/1318 Photo-theodolit and Topocart and Autosterograph 1318 instrument. The accuracy as following:

TEST AREA	AVERAGE PHOTO-SCALE	MAP SCALE	INSTRUMENT	ACCURACY	
				M_s	M_h
A	1:4500	1:2000	TOPOCART	0.45m	0.35m
B	1:3100	1:1000	1318	0.38	0.30

2.3 Engineering survey

(1) The deformation monitor of the coal preparation building: The photo taken by JENA 19/1318 Photo-theodolit is measured on PSK-2 Comparator. The data is proceeded with the Coplanar and Direct Linear Transformation. When we introduce the radial distortion of the lens in to the equation, the method is based on the following pair of equation:

$$x+xr^2K-\frac{l_1x+l_2y+l_3z+l_4}{l_9x+l_{10}y+l_{11}z+1}=0$$

$$y+yr^2K-\frac{l_5x+l_6y+l_7z+l_8}{l_9x+l_{10}y+l_{11}z+1}=0$$

where

r -the radial distence of the image, $r=\sqrt{(x-x_0)^2+(y-y_0)^2}$

K -the radial distortion coefficient

l -the function of orienlation element, principle distence and linear correction

Above equation can be reduced to the following matrix equation:

$$\begin{bmatrix} X & Y & Z & 1 & 0 & 0 & 0 & 0 & -xX & -xY & -xZ & -xr \\ 0 & 0 & 0 & 0 & X & Y & Z & 1 & -yX & -yY & -yZ & -yr \end{bmatrix} - L - \frac{1}{A}\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} V_x \\ V_y \end{bmatrix}$$

where

$L=[1\ 1\ 1\ 1\cdots 1\ K]^T$

$A=l_9x+l_{10}y+l_{11}z+1$

We have 12 unknown elements in the equation, so more than 6 control points are needed. The results of the monitor points approch 1-2cm.

(2) The measurement of strip of a open-pit mine:

The stereophoto is taken periodically at the fixed station with B=31m, y=400m. Using the 1318 Autostereograph measures top-line, base-line and hight points every 2-3cm. The area is calculated by integraph. At last the quantity of strip could be heted. For this kind of work, photogrammetry methor is much better than old one. It is more efficient, accuracy and less laboured work.

(3) The acquisition of geolohy information by the method of the close-up photogrammetry. Using SMK-120 stereo-camera and Comparator measures 4-6 points on the geological body plane, then calculate the strike-dip on the plane by following formula:

$$P_1y+P_2x+P_3z = 1$$

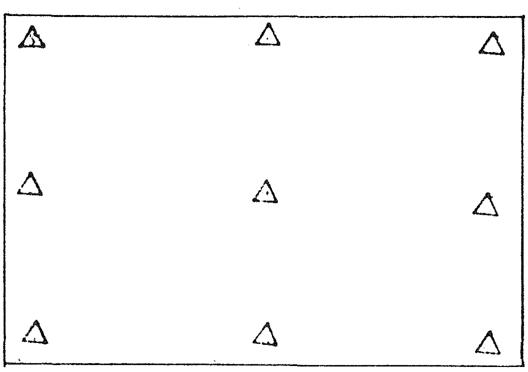
When getting the coefficients P , P , P , following formulae is used for calculation of the elements of strike-dip:

Dip-angle: $\alpha = \mathrm{arctg}\ (P_1^2+P_2^2)^{\frac{1}{2}}/P_3$

Strike : $\delta = \mathrm{arctg}(P_1/P_2) + A$; A is the azimuth of photo-base

The close-up is not only to get the strike-dip but we can get the interval of fault and the thickness of the different geological bodies at same time.

2.4 The lower class control network of coal mine can be established by analytical aerotriangulation. Using independent model method, the area is 9km 11km. The control points are set up as follows:



LMK AERIAL CAMERA with compensation of linear image motion is used. Photo scale is 1:11000. The focal length of photo camera f_k = 152mm . The fore-and-aft overlap is 60%. The lateral overlap is 55% . Whole test area has 11 strips. All control points are marked. The photo coordinate are taken on the PSK-2 Comparator. The results of block are: M_c =0.18m. It can be met the requirment for the lower class network of coal mine.

3. Conclusion and perspection

Based on the experiment for years. The photogrammetry can resolve various terrain survey task economically, especialy for repetition task and map revision.

We also can expect, taking digital technology for data collection and setting up mining data base,can make the photogrammetry information directly for application of mining planing, design, construction and administration.