The Application of Close-range Photogrammetry Measurement for Landslide Monitoring

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Abstract

Landslide as a phenomenon of frequent occurrence in earthquake zone, for landslide deformation monitoring, traditional routine measurement methods exist problems, such as fussy operation, workload big, high cost, the large demand of personnel and low measurement accuracy. Recently, Close-range Photogrammetry has gradually become the main trend of monitoring method. The content of this paper is based on the principle of Close-range Photogrammetry, combining with the close-range measurement in monitoring and other applications and analyzing the advantage and the calibration method of camera. What's more, using Virtuozo software and camera calibration technology, it can also reach further constructive prevention advice. To discover whether there is a deformation in time, and carry on the reinforcement. Lay a solid foundation in landslide monitoring for further research.

Keywords

Close-range Photogrammetry; Landslide; Camera Calibration; Deformation Monitoring.

1. Introduction

Because of the influence of the terrain environment and soil types, slope diastereomers cause the downward trend, once the rock resistance is less than the destructive, landslide, collapse and debris flow disasters will happen. Slope instability disaster once occurred, due to the higher the slope, the greater the volume and faster moving speed, the greater damage will be caused. It will lead to disaster area casualties and property losses; seriously, and it may endanger the whole disasters in cities and towns. Therefore, the slope deformation monitoring can effectively assess risk, and reduce the slope collapse. Also it can reduce the disasters such as landslide, the probability of occurrence and prevent disasters effectively in a certain extent.

At present, in terms of slope monitoring method, domestic and foreign scholars has made a lot of research work, also has obtained certain achievements [1-4], but the use of close range photogrammetry method for monitoring research is less. The traditional slope monitoring methods are to use the measuring method and GPS measurement method on the surface deformation displacement monitoring. Geodesy technology application in deformation monitoring, early start, but owing to the large field measurement, with absolute accuracy is low, its application was limited; GPS method has high precision and the cost of inputs is more expensive. And the close range photogrammetry, which is developing rapidly in recent years has become the mainstream of the future measurement method, compared with the traditional technology, the close range photogrammetry has low cost, high flexibility, high precision, etc. ZHANG Zuxun [5] used Lensphoto measuring instrument of deformation measurement, and through the analysis to obtain accurate results, but the multiple baseline digital close range photogrammetry technology is not high popularity. This paper on the basis of the theory of close range

photogrammetry, with low cost and simple operation, and has already ordinary calibrated [6] digital camera [8] to abtain the target points on the landslide information, And combining the VirtuoZo [9] to analyze the image, which is the mature technology, can obtain accurate analysis results of deformation.

2. The calibration of Digital camera

As an important part of the whole process of the close range photogrammetry, it is necessary to check and correct non-metric digital camera (mainly includes the inner orientation elements, the object lens optical distortion and other parameters) used in the process of photogrammetry.

2.1 Camera self-calibration method and calibration method based on active vision

Given the absolute distance of an arbitrary two reference point, camera self-calibration don't need to known reference and other space 3d information or the parameters of the camera, only need to calculate the camera parameters by using the constraint relationship between the multiple imaging. If there is no information of dimension, for the focal length, translation vector, target structure parameters such as size, it can only get the coefficient of the ratio between the various parameters, unable to determine the specific values when calibration results are gotten at the case of differing a scale factor. Self-calibration does not need to initial value, and thus is different from the method, which calculate the exact value of camera and target parameter through beam adjustment optimization algorithm on the basis of known initial value. Poor flat beam optimization methods sometimes need to provide initial value through the calibration. As research focus of computer vision community, many researchers are still exploring its calibration method.

The calibration method based on active vision need to control the movement of the camera to do some controllable movement, the particularity of motion is used to calculate the camera parameters, because the camera have controllable, so this method has been widely used.

Compared with other calibration methods, by the analysis of volume, precision and the test equipment, this experiment selects the traditional camera calibration method, through the using of calibration plate threatening the camera in the laboratory. It can be demarcated by using matlab.

3. The implementation plan of Close range photogrammetry monitoring system

3.1 The design of monitoring plan

According to the analysis of terrain and topography of the area under test, set the measurement digital camera fixed on monitoring in two different locations, as well as the slope range observation point composition image overlap, and combining the VirtuoZo software of highway slope regularly taken image matching analysis of the main landmark, solution to calculate the deformation of the target body. For testing the accuracy of its results, should be first measured with total station, by assuming coordinates, of the coordinates of the main control points and the landmark information and data gained by the close range photogrammetry monitoring, compare and analyze the accuracy of the results. To grasp the actual shape of deformation, and put forward prevention Suggestions, in order to avoid the occurrence of disasters, provide necessary for economic development and people's life safety and effective information.

3.2 The selection of marking point

Regardless of the use of any method of measurement, it is required to set the control points used to test the accuracy or convenience of calculation. Therefore, using artificial markers as the target point to be measured can bring convenience to the measurement [10]. Choosing the appropriate artificial mark can check the quality of the measurement and improve the accuracy and reliability of the measurement.

In this measurement, it is necessary to shoot a landslide, in order to obtain the slope displacement information, considering all kinds of artificial mark points and objective measurement, through analysis of the photographed object properties, characteristics and the precision requirement, in artificial signs in

the shape and the material selection are determined, using below the marked points as the survey control point markers.

Fig.1 The mark of square opposite angles

A 80cm ×80cm square is divided into four parts, in order to enable the sign clearly visible, easy sighting, respectively, with the two on the apex part made of black, two opposite angles made of white, the sign due to distinct black and white contrast color, easily to identify, and the measurement precision is high. Material selection of paper, in order to avoid the external environment of heavy moisture, the above is covered with waterproof film so as to avoid the influence of the environment.

3.3 The layout of landmarks

According to the close range photogrammetry deformation monitoring, the measured range were designed on the basis of highway slope 10 control points, and the fixed, artificial landmark selecting stable measurement control points set up on the highway, laying on the slope measurement, the artificial landmark by measuring the slope of layout of regional landmark coordinates to monitor the displacement of the slope deformation. The layout of the specific landmark as shown below:

Fig. 2 Monitoring of highway side slope body

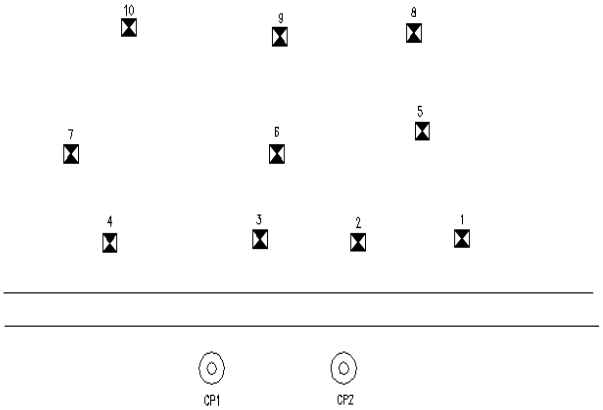

Fig.3 Layout of landmark

4. The implement of the control survey work

The monitoring object is north of the small slope of highway, the terrain is partial, with a height of about 10m, covers an area of about 450m^2, traffic less, flat road, but slope has certain gradient, so select the on the part of the slope as the measuring range, not only can reduce the amount of work measurement, but also by some to look at the overall deformation trend. According to the observed slope area and

deformation of the larger area, set the number and location of the mark points, by using the total station measurement, get the mark point of the coordinate value [11-12].

Table 1. The data of landmarks of Total station measuring

dit	X	Y	Z
1	3801975.870	37403288.976	1260.946
2	3801961.717	37403234.676	1260.879
3	3801934.560	37403126.641	1261.848
4	3801886.753	37403019.636	1262.121
5	3801986.995	37403155.587	1272.507
6	3801950.182	37402973.561	1272.856
7	3801876.838	37403275.642	1273.652
8	3801992.050	37403275.642	1284.234
9	3801973.551	37403201.892	1285.854
10	3801939.510	37403085.663	1286.075

The location was measured using a TOPCON GPT-3000LN total station instrument, the measurement accuracy is 2 ", the ranging accuracy for 2+2ppm. In the measurement process, the crosshairs center and marking at the center of the strict coincidence to ensure the accuracy of the measurement results. After observing a measure, in order to improve the measurement accuracy, the average value of the two measurements is measured as a result.

4.1 Acquisition of digital image

This experiment used camera for Nikon D300, a high performance digital SLR camera, its effective pixels for 12.3 million, with a 23.6 ×15.8 mm of CMOS sensor. As for a non-metric camera, so it need to be calibrated by laboratory calibration method. The camera is placed in a fixed position, and the left and right images of the slope are obtained by using the method of cross photography. In order to improve the quality of images on the slope deformation of close range photogrammetry, image acquisition process in the industry need to follow the following principles:

Select appropriate shooting angle, try to make two photography center lines are close to 90 degree, particular case is shown in the figure below:

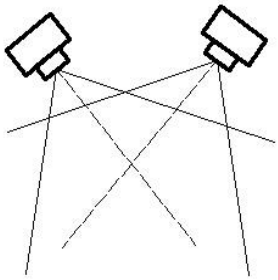

Fig. 4 Camera position of close range photogrammetry

2. Ensure a high degree of overlap between pictures.

3. To prevent subsequent processing image in accuracy is not high enough, should be taken in shooting area measurement more images, choose suitable six pictures for processing and modeling.

4. Select easy to identify feature points as the basis of image matching.

To improve the accuracy of measurement, combining with shooting the actual geographical environment of test area, try to choose the stable control points set up the tripod to fixed camera to reduce the error of camera shake, and at this point to get the whole test area much figure, image figure should be included in the set of all landmark.

4.2 The analysis of data processing results

By introducing image file menu item, VirtuoZo file - will be ready to good jpeg format images into VirtuoZo format, according to the needs, choose the appropriate image matching.

The work is based on close range photogrammetry module and digital elevation model (DEM) production function in the system, for each intake slope stereo like the one by one relative orientation. Work flow diagram as shown below:

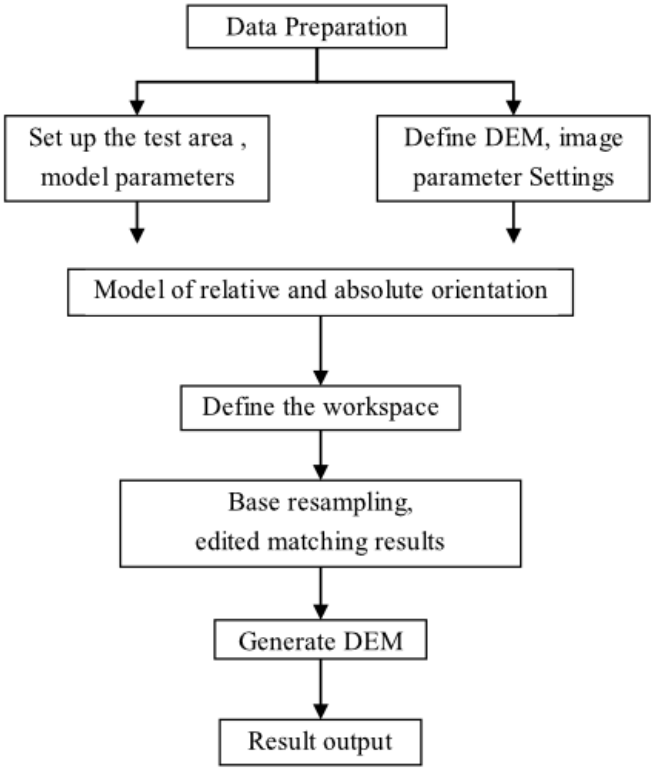

Fig. 5 The flowchat of VirtuoZo

4.3 The analysis if the deformation result

By adding the same name as points 6 points, the coordinates obtained by using the VirtuoZo software to process were shown in the following table

Table 2. Results for the data processing

coord	2014 -04-06	2014-05-28	Deviation（m）
X	3801950.180237	3801950.186257	0.00102
Y	37403155.587135	37403155.591253	0.001118
Z	1272.856432	1272.863471	0.001961

Images of the last generation output DEM vector images

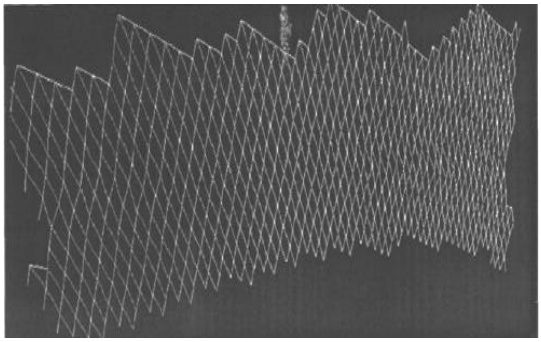

Fig. 6 On April 6 images generated by DEM

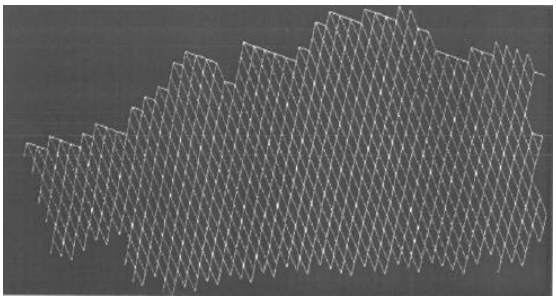

Fig. 7 On May 15, the image to generate DEM

Fig. 8 DEM comparision

Can be seen from the results, the use of close range measurement of highway slope deformation monitoring can achieve higher precision, and the maximum deformation of slope is 13 mm. So, can get the following conclusion:

1. Using the measuring camera Nikon D300 application of similar monitoring image can achieve higher precision of data acquisition, through the contrastive analysis of the results figure, it is concluded that using a digital camera on the implementation of close range photogrammetry is applied in the landslide deformation measurement is feasible.

2. For a 10 landmark in test area, you can use the close range photogrammetry images of multiple observation points measured at same time, so as to realize the overall monitoring of the slope deformation.

3. Digital camera not measurement is adopted in close range photogrammetry costs less than measurement cameras with the traditional monitoring methods, and the field work, data processing work in the industry. If the error in the image acquisition process, will directly affect the subsequent data calculation and analysis, can't get the correct conclusion.

5. Conclusion

(1) Due to the camera parameters are directly affected by shooting results, so quantity measured calibration of digital camera can not be ignored, is different from traditional measurement camera and needs to the traditional camera calibration method in the laboratory by calibration board to get the camera parameters and optical distortion value.

(2) Choosing the right field position and getting plenty of data can improve the accuracy of analysis in the industry.

(3) Using computer VituoZo software system to be carried out in accordance with the sequence of operation strictly, select photos that could satisfy the requirement of precision processing to analyze.

(4) Close range photogrammetry technology can be instantly get for landslides of the target body complete data information, can be dealt with through software for visual information for analysis. But because of its easy measurement, it results in late prophase work of complex, if you have any wrong

images, it will directly affect the measurement result error analysis, so measurement personnel must have a certain theoretical knowledge reserves.

6. Outlook

Influenced by time constraints, not on the in-depth research, during the encounter a lot of problems and does not have the proper treatment, therefore, put forward suggestions:

Because there is no guarantee that the nonlinear distortion of lens and the outdoor environment have no effect on the monitoring results, so, the camera calibration process still exist some problems remain to be improved.

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