Study on Digital Earthquake-before Damage Evaluation

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ABSTRACT :

Buildings digital auxiliary classification, summation of different kinds of buildings area, for earthquake-before damage evaluation investigation, by integrated application of RS (Remote Sensing) and DPS (Digital Photogrammetry System) and otherwise digital method are studied. Two kinds of buildings digital auxiliary classification methods for earthquake-before damage evaluation have been used. If there are remote sensing image stereo pairs in the evaluated area, DPS can be used. A number of DSM (digital surface models) of three-dimensional structures and DEM can be obtained. There is another earthquake-before damage evaluation survey method that buildings height are calculated automatically by buildings shadows in remote sensing image. Buildings can be aided classified by height. According to formulas of aerial survey, buildings' height can be calculated by the shadows. The buildings shadows can be picked up by a series of RS image transformations. The area summation of different kind of buildings can be obtained by GIS. Digital earthquake-before damage evaluation, which combines digital technology with experience and statistical evaluation, is faster than traditional methods.

KEYWORDS: Digital classification, Earthquake-before damage evaluation, DPS, RS

1. INTRODUCTION

Digital technology has been applied to prevention and reduction disaster in recent years. RS and DPS, two kinds of digital technology have been applied to earthquake before damage evaluation and environment change measurement.

Narpat Singh Rathore utilized RS, to study topography change earthquake bringing. Nioki Ogawa and Hirotada Hasegawa estimated respectively earthquake damage of wood buildings by Kobe earthquake aerial remote sensing images. Some micro vertical diastrophism of active fault was monitored and surveyed utilizing radar images. Earthquake tectonic maps of remote sensing images interpretation in china have been compiled by seismologists and rocksies and earthquake engineering scientists in the sevens of the twentieth century. Aerial remote sensing images were interpreted artifically by Decheng Zhang for earthquake damage evaluation of buildings in 1993. The aerial remote sensing images were utilized by Yang Zhe to investigation of Lanchang-Gengma earthquake disaster. Earthquake damage evaluation of disaster area was studied by Zhang Jingfa contrasting radar remote sensing earthquake stricken before with after.

Change of topographic and wild sight was studied by Gong Peng with DPS. Performance of concrete girder bearing shearing force was studied by Qu Zhe with DPS.

Automatic extraction of shadows from high resolution spatial satellite images were studied by Xu Miaozhong. The distribution information of different heights building in a city was extracted from the shadows in an Ikonos image by Xie Junfei.

Earthquake before damage evaluation in china began in the sevens last century after Tangshan earthquake. The earthquake vulnerability analysis is the primary means for earthquake before damage evaluation. The structure will be destroyed if outside force put is over a threshold, this can be evaluated and calculated by a number of parameters on type of buildings and building materials and so on. First of all works for earthquake before damage evaluation, the buildings are classified according to the principles of vulnerability classification. The principles of vulnerability categories are according to earthquake damage with similar buildings in the past earthquakes. The field survey of the evaluation area was the basis for earthquake vulnerability calculation. Sample buildings were surveyed detailedly for statistical calculation of vulnerability. The more sample buildings the better the result of statistical calculation is.

In traditional field survey of earthquake before damage evaluation, a number of representative buildings chosen from each kind of general-purpose buildings were surveyed one by one. A series of information for earthquake before damage evaluation can be obtained by calculating with results surveyed. A lot of field survey information can be obtained by digital technology. People on the ground of limited sight, are lack of overall macro distribution of different type buildings. The buildings are overlooked in the air utilizing RS and DPS. There are characteristics of overlay area extensive and evaluation fast. RS and DPS digital technology were applied to aid classification on field survey for earthquake before damage evaluation.

2. EARTHQUAKE BEFORE DAMAGE EVALUATION WITH DPS

Pairs of aerial anaglyphs in Beijing were utilized for digital test. DPS software was utilized for relative orientation and absolute orientation and matching editing, DSM and DEM were constructed. The height of buildings was obtained automatically. Buildings were classified by height, assisting survey for earthquake before damage evaluation.

After setting parameters and survey area being set up, the model was set up and orientated. Nuclear-line was resampled and Nuclear-line image was obtained. A part of three-dimensional model of buildings is shown in figure 1.Buildings were measured by digital measure of DPS. Finally, the digital map with three-dimensional coordinates of buildings was obtained in the end and is shown in figure 2.

Figure 1 three-dimensional model of buildings

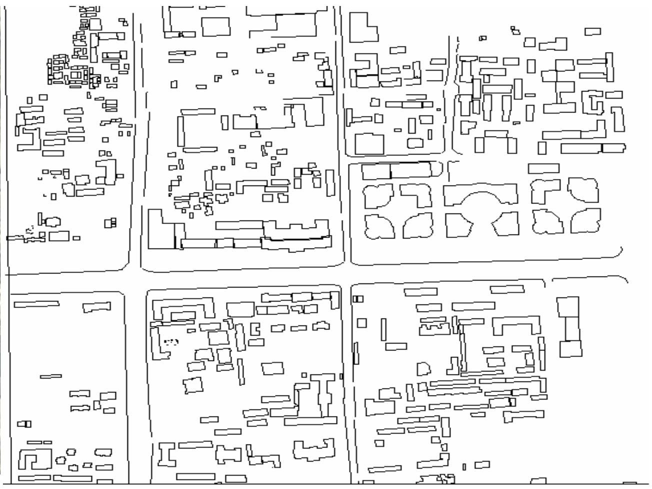

Figure2 results of the digital mapping

More than 600 buildings were digital measured in the digital test. The information of DSM and DEM and the types of building roof were obtained. The height of a building can be obtained by formula 2.1.

$$h = DSM\text{-}DEM \qquad (2.1)$$

In formula 2.1, h is a building height, DSM is a value of digital surface model and DEM is a value of digital elevation model.

According to the height of the building and each floor, the number of floors was calculated. A total building area was calculated by the plane area and the number of floors. The digital test results are shown in table 2.1.

Table 2.1 Results of digital faster buildings classification in test area

Cottage		Multi-storey building		High building	
Number	Total area(m^2)	Number	Total area (m^2)	Number	Total area (m^2)
203	33325.994	354	947950.175	92	1465983.383

3.EARTHQUAKE-BEFORE DAMAGE EVALUATION WITH RS AND SHADOW

The information on drop shadow of buildings can be extracted automatically by RS. The building height was calculated with drop shadow. Assisted classification for earthquake before damage evaluation with RS and building shadow was studied.

Processed with geometric correction and enhancement and so on, the remote sensing image was classified, unsupervised and supervised. Part of unsupervised classification results are shown in figure 3.

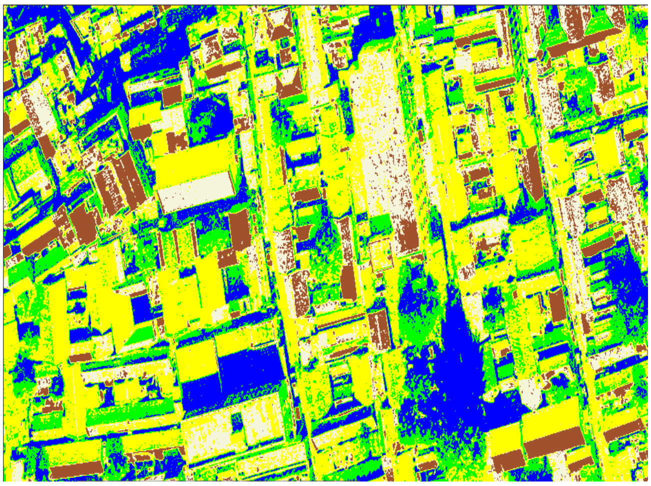

Figure 3 Partial unsupervised classification results

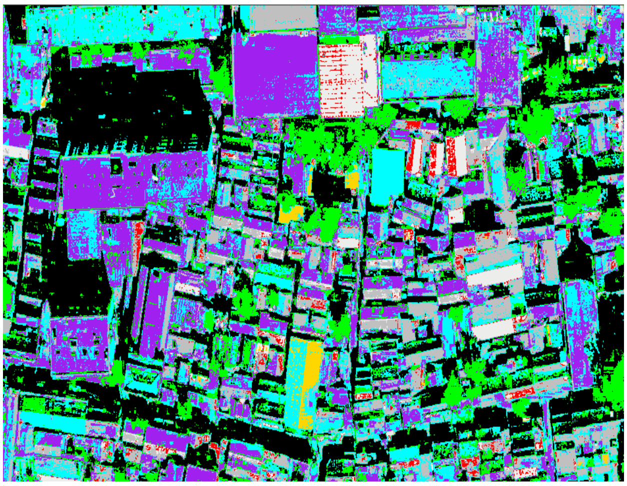

Figure4 Partial supervised classification results

Blue represented drop shadow of buildings in figure 3. Other kinds of color represented different kind of buildings roof , a part of buildings , road, trees and so on. There were some confusion categories between shadow and water, buildings and roads. It can be improved by aided information.

After unsupervised classifying, supervised classification is utilized. Trees, buildings with five color roof, roads and drop shadow are included in supervised classification template. The possibility matrix was utilized to estimate classification template and it is shown in table 3.1.

Table 3.1 Possibility matrix to estimate classification template

Result \ Temple / Objects	Tree	East-west	Grey roof	Brown roof	Light-grey roof	White roof	Road	Shadow
Tree	11276	12	3	0	10	0	0	162
East-west	30	964	509	0	48	0	0	0

Grey roof	7	9	4628	0	3	61	3	0
Brown roof	0	0	0	528	0	0	0	0
Light-grey roof	12	8	17	0	991	0	0	0
White roof	0	0	30	0	0	740	36	0
Road	0	0	465	0	0	51	550	0
Shadow	445	1	0	0	0	0	0	4685
Total	11770	994	5652	528	1052	852	589	4847

The classification results are more satisfactory. There are some confused category to be improved between roads and buildings. The results need to be improved through referring to special topic and field survey information. Partial supervised category results are shown in figure 4.

In figure 4, green represented trees. Blue, grey, yellow, purple and white represented different color roof of buildings. Black represented drop shadow of buildings.

According to aerial survey formulae, buildings height is calculated with buildings shadow. The length of buildings shadow extracted automatically by RS, as shown in figure 3, was calculated automatically by GIS. Shadow of the buildings were measured, the partial results are shown in table 3.2.

Table 3.2 Buildings shadow length calculated automatically

Number	Shadow length(m)	Number	Shadow length (m)	Number	Shadow length (m)
10	20.8173	19	13.0384	28	17.366635
11	23.021729	20	8.485281	29	28.319605
12	23.64148	21	3.622154	30	19.284
13	18.508376	22	17.075128	31	8.551023
14	9.338094	23	34.567615	32	8.318654
15	8.551023	24	4.701644	33	22.951253
16	15.770859	25	4.837355	34	16.643317
17	6.003	26	7.002857	35	5.60357
18	13.0384	27	9.535198	36	22.598521

According to shadow as above, building height and floor number are calculated. The results are shown in table 3.3.

Table 3.3 Buildings height and floor number

Number	Height(m)	Floor number	Opinion	Number	Height(m)	Floor number	Opinion
10	22.212	7	right	24	5.0166	1	right
11	24.5641	8	right	25	5.1614	1	right
12	25.2254	8	right	26	7.472	2	right
13	19.7484	6	right	27	10.174	3	right
14	9.9637	3	right	28	18.5302	6	right
15	9.1239	3	right	29	30.217	10	right
16	16.8275	5	right	30	20.576	6	right
17	6.4052	2	right	31	9.1239	3	right
18	13.9119	4	right	32	8.876	2	right

19	13.9119	4	right	33	24.4889	8	right
20	9.0538	3	right	34	17.7584	5	right
21	3.8648	1	low value	35	5.979	2	more low
22	18.2191	6	right	36	24.1126	8	right
23	36.8836	12	right				

Comparison results between digital and actual classification, the accurate rate is 80%.The accurate rate of classification for low-rise and smaller buildings is not ideal because the buildings distribution was denser and there were a lot of high-rise buildings in the test area.

4. CONCLUSION

The digital technology can play an important part in earthquake damage evaluation when it is more dificult to field survey. The RS and DPS can be utilized to quantitative survey of wide scope in a short period of time by interpreting high image. The results can covered a broad area and be more precision. To improve the efficiency of earthquake before damage evaluation using digital technology is a very significant. It is great importance to development of prevention and reduction earthquake disaster.

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