ON THE AID OF SPECTRUM ANALYSIS FOR IMAGE MATCHING

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Abstract: Image matching is an important step to locate conjugates for the three-dimensional analysis.In various matching studies, the area-based concept is straight-forward such as Normalized Cross-Correlation (NCC), and Least Squares matching (LSM), using local gray level to find the correlation independently. Close-range images contain the detail spectral information, but occlusion and similar textures may cause ambiguities and matching errors. In order to improve the matching accuracy, this study integrates the spectral information to estimate the location of similar textures for close-range image matching. The proposed scheme containsimage classification, multiple matching window design, similarity assessment, and image matching integration.First, image classification groups the whole gray value and providesadditional information for image matching.Second, image resampling, and Center-Left-Rightmatchingassists image matching windows with the distance discontinuity around building texture edge. Then, matching index estimates the similarity. At last, image matching integratesall of the indices to derive a large amount of conjugate points. Experimental results show that the method can improve the accuracy of image matching.

1. INTRODUCTION

Image matching is an important step to locate conjugates for three-dimensional analysis. Building modeling is one of the most prominent tasksin geographic information systems. Building modeling includes geometric modeling and texture mapping.Many three-dimension points describe the geometry of building model in the object space. Images can rebuild the object space coordinate and supply texture for building model. Both of geometric modeling and texture mappingneed tolocate conjugates.

There are two main methods for image matching, area-based matching and feature-base matching. The area-based concept is straight-forward,it waslocal gray level to find the correlation. For example: Normalized Cross-Correlation (NCC)[Pratt,1991], Least Squares matching (LSM). Feature-based matching comprises size and shape of feature [Fraser, 2009], like Scale-invariant Feature Transform (SIFT)[Lowe, 2004], Smallest Univalue Segment Assimilating Nucleus (SUSAN) [Smith and Brady,1997],and Features from Accelerated Segment Test (FAST) [Rosten and Drummond, 2006]. In addition tolocal gray value estimation, many studies proposed matching processing bythe integration of epipolar geometry [Han and Park, 2000; Zhang and Green, 2006].Otto and Chua[1989]proposed geometrically constrained cross-correlation (GC^3) method, whichemploys a set of satellite images in a strip to improve the accuracy of positioning. In epipolar geometry, Center-Left-Right (CLR)[Hsu, 1999] matchingassists image matching with the distance discontinuity around building texture edge.Then, in close-range image matching has tilt displacement, relief displacement, and occlusion seriously. In order to improve the matching accuracy, this study intensified image matching with spectral information to estimate the location of similar textures.

2. METHODOLOGIES

In this study, we use a set of close-range image which acquire from different view angles. The proposed scheme includes matching approach and similarity assessment.

Matching Approach

Image matching is a method which can find location of conjugates automatically. Close-range images acquired from different distances and different view angles, thus, they have different spatialresolutions. In the study, we project the object space coordinates on each image.Then, geometrically constrained cross-correlation (GC^3) methodemploys object space matching.We can find conjugate points in multiple close range image at the same time, but there are some occlusions. In order to improve the image matching result, this investigation employsCenter-Left-Rightmatching, to cope with the difficulties by the discontinuity in the multiple image matching.Object space matching is shown in Figure 1.

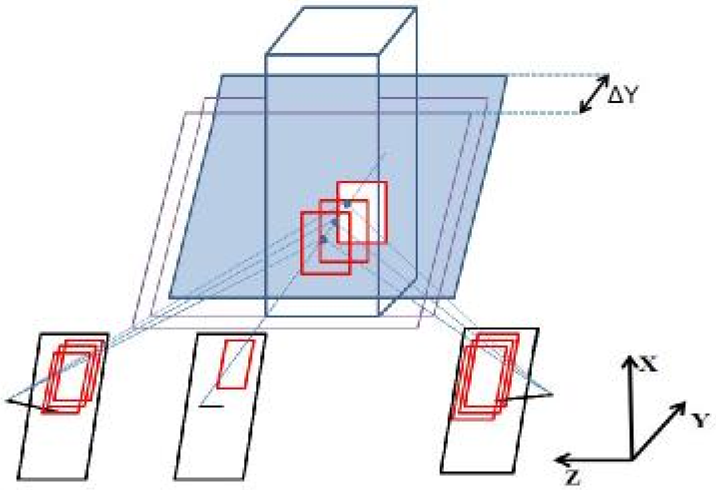


Figure 1: Object space matching

Similarity Assessment

Close-range images are subject to significant geometry distortion, such as tilt displacement, relief displacement, and occlusion seriously. To improve the matching accuracy,two indexes for determining similarity.One is Normalized Cross-Correlation, the other is a classification index. NCC is a common method, which compares the similarity between local gray levels. Classification can group the whole gray values and provide category information.In the study, we supposed that conjugate points have same category and classification index could help the matching.Therefore,the study combines two kinds of similarityassessments in image matching. The sample for classification index is shown in Figure 2.The relationship between classification and similarity is shown in Figure3.

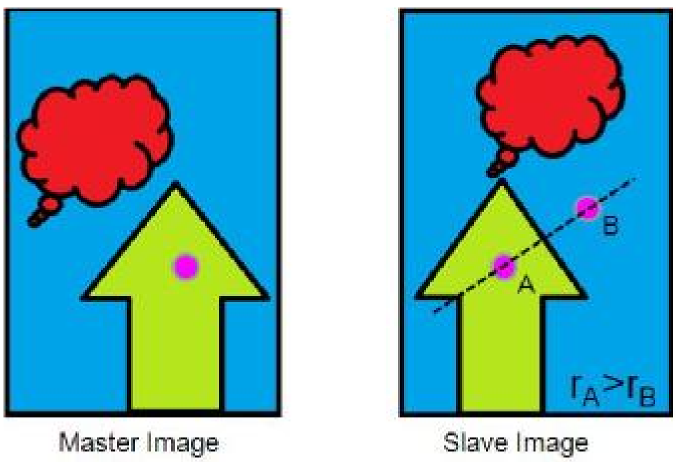


Figure 2: The relationship between classification and similarity

1	1	1	2	2
2	0	2	2	1
2	2	1	1	1
2	1	1	1	1
2	2	2	2	2

2	2	2	2	2
0	0	2	2	1
0	0	1	1	1
2	0	0	1	1
2	2	0	2	2

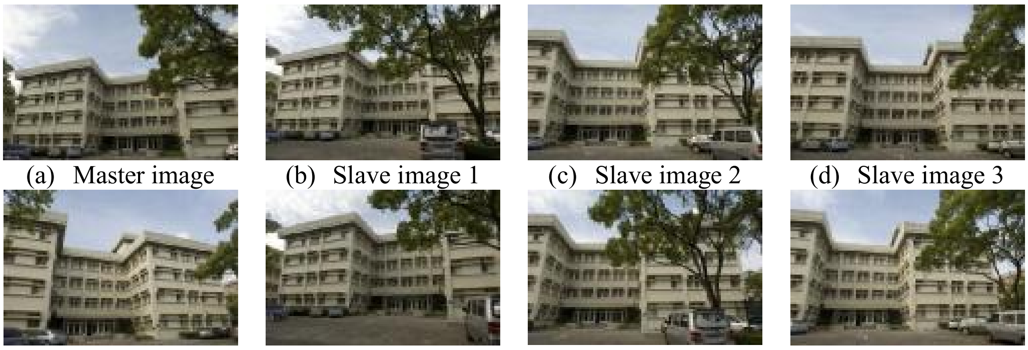
0	0	0	1	1
0	1	1	1	1
0	0	1	1	1
1	0	0	1	1
1	1	0	1	1

(a) Classification in master image (b) Classification in slave image(c) Compare the similar between two images

Figure 3: The sample for classification index

3. EXPERIMENTAL RESULTS

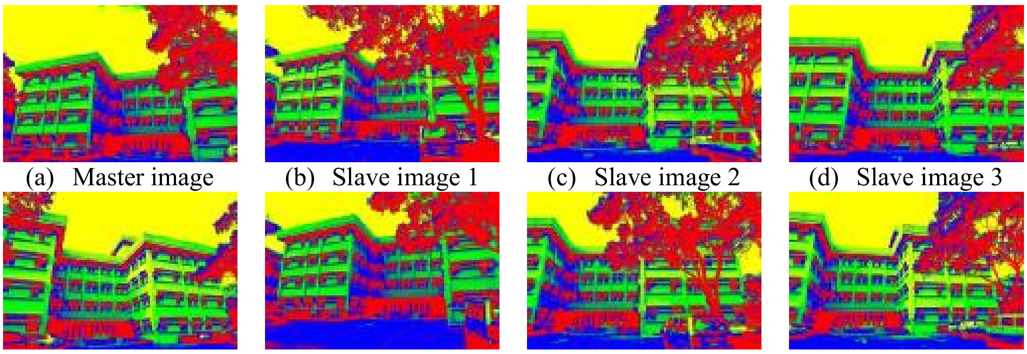
The study proposed spectrum analysis in image matching. In the experimental result, we compare our method with the traditional approach. The test area is CSRSR building at National Central University of Taiwan. There are eight images acquired from different view angles. Overlap is about 90% and spatial resolution is 1centimeter. The test area images are shown in Figure 4.



(a) Master image (b) Slave image 1 (c) Slave image 2 (d) Slave image 3
(e) Slave image 4 (f) Slave image 5 (g) Slave image 6 (h) Slave image 7

Figure 4: The test area images

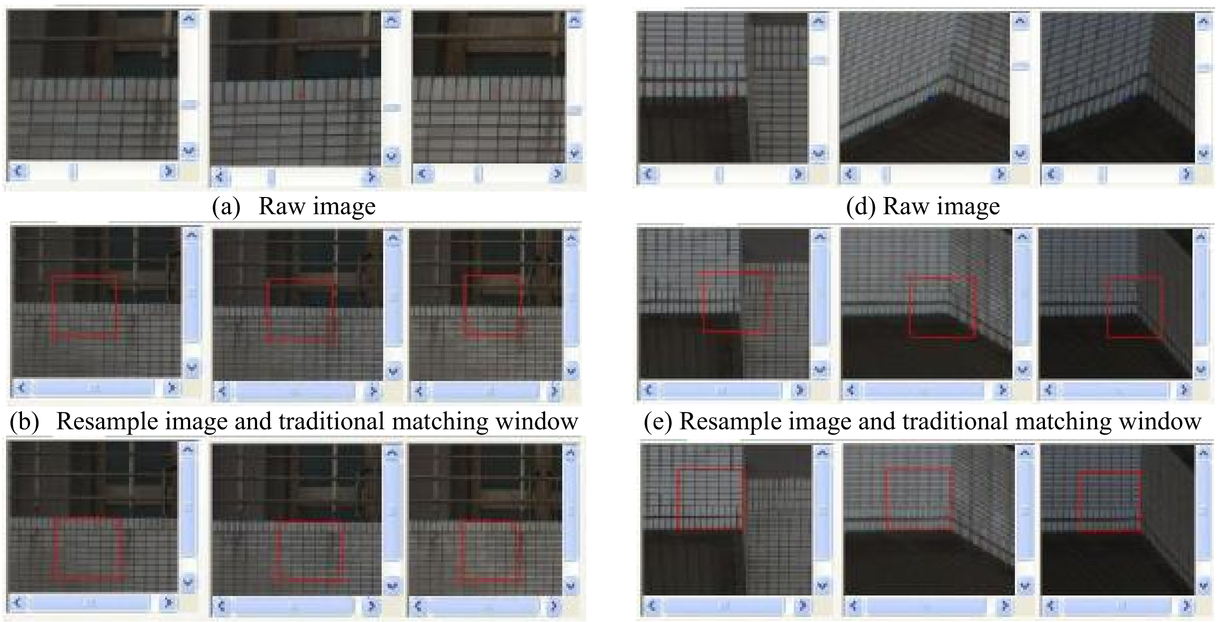
Classification separated the building and occlusion, i.e.occlusion in red, and buildingin green.Therefore, they provided additional information to image matching. Classification images are shown in Figure 5.



(a) Master image (b) Slave image 1 (c) Slave image 2 (d) Slave image 3
(e) Slave image 4 (f) Slave image 5 (g) Slave image 6 (h) Slave image 7

Figure 5: Classification images

Center-Left-Right (CLR) matching window can cover the same target area. The results of matching window are shown in Figure 6. Then, we integrated into feature matching, classification information, multiple matching window, and two matching indexes. Through Geometrically Constrained Cross-Correlation, we get a large amount of conjugate points for 3D point cloud generation. 3D point clouds are shown in Figure7. Most of them are located on building surface.



(a) Raw image (d) Raw image

(b) Resample image and traditional matching window (e) Resample image and traditional matching window

(c) Resample image and CLR matching window (f) Resample image and CLR matching window

Figure 6: The results for matching window

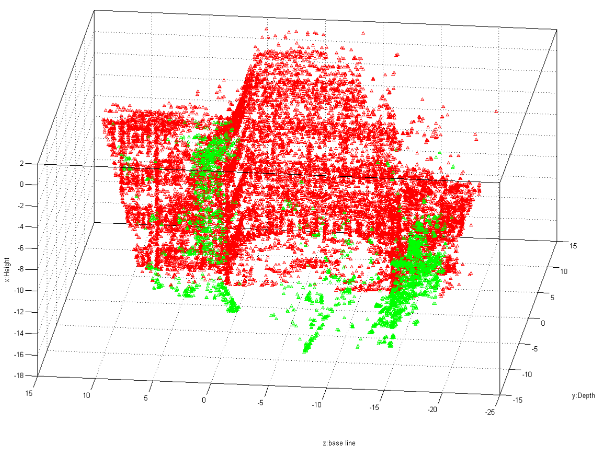


Figure 7:3D point clouds

The number of matching successful points is about 30%. For estimation the accuracy of matching result, we check the coordinate of image and object space.The rule of image matching validation is shown in Table 1. Besides, we compare the method with traditional approach. Our method has more correct points and improves the accuracy for point location.The number of matching are shown In Table 2. The results of image matching are shown in Figurer 8.

Table 1: The rule of image matching validation

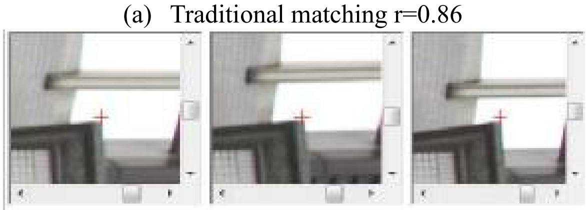
Table 2: The number of validation

Total points		Distance of 3D point	
		occlusion	building
Image location	occlusion	**correct**	wrong
	building	wrong	**correct**

Test area	Traditional matching	Assist classification matching
Occlusion correct%	1.12	0.61
Building correct %	76.40	89.20
Total correct %	77.52	89.81


(a) Traditional matching r=0.86


(c) Traditional matchingr=0.85


(b) Assist with spectrum analysis matching r=0.94

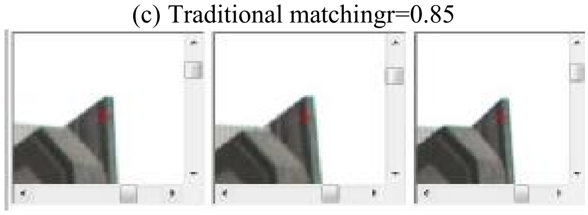

(d) Assist with spectrum analysis matching r=0.94

Figure 8:3D point clouds

4. CONCLUSIONSAND FUTURE WORKS

The study integrates feature matching, classification information, multiplematching windows, and two matching indexes to estimate the location for images. Experimental results show that our method can improve at least 10% accuracy for this test area.The method provides higher correlation coefficient in image matching. Beside, result shows classification can assist image matching. In the result, most of points locate in building surface; few of them are occlusion points. In the future, we will improve the matching method for the occlusion part.

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