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GISC9216D3
Apr 6, 2018

Technical Memorandum

Course:	Digital Image Processing		
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Subject:	*Deliverable 3– Orthorectification*		
Date:	April 16, 2018	**Project Code:**	GISC9216D3

1.0 Introduction

Orthorectification is a process of using an orthoimagery, which is geographically coordinated, to rectify an aerial photograph with common features on both imageries. This process is essential for digitizing aerial photographs with correct and accurate geographical locations. It also helps eliminating terrain distortions to increate location accuracy. The rectified aerial photos can be combined using the process of mosaic to form the whole area with higher accuracy. This exercise serves a purpose of performing orthorectification for the three aerial photos and mosaic to form an area using ERDAS Imagine. The exercise helps understanding the concepts of the two processes and gaining familiarity of functions in ERDAS Imagine.

2.0 Methodology

Geometrical correction is the first step for orthorectification. This process was done manually and was required precise location for the aerial photos to be geographically accurate. Two types of geometrical corrections, polynomial and camera, were performed to the three aerial photos prior to the mosaic process. Polynomial mode simply match both imageries based on the GCPs while camera mode uses elevation file (Digital Elevation Model) and given parameters to increase the accuracy to match both imageries on specific location. The three aerial photos in TIF format were being orthorectified using the Ground Control Points (GCPs) function. A geographically coordinated subset imagery was used referenced to perform this process. By finding the common features on both imageries such as roads and edge of the house roof, 10 GCPs were applied on the aerial photo and the subset imagery (Figure 1). After entering three GCPs the software will start making predictions on the fourth point.

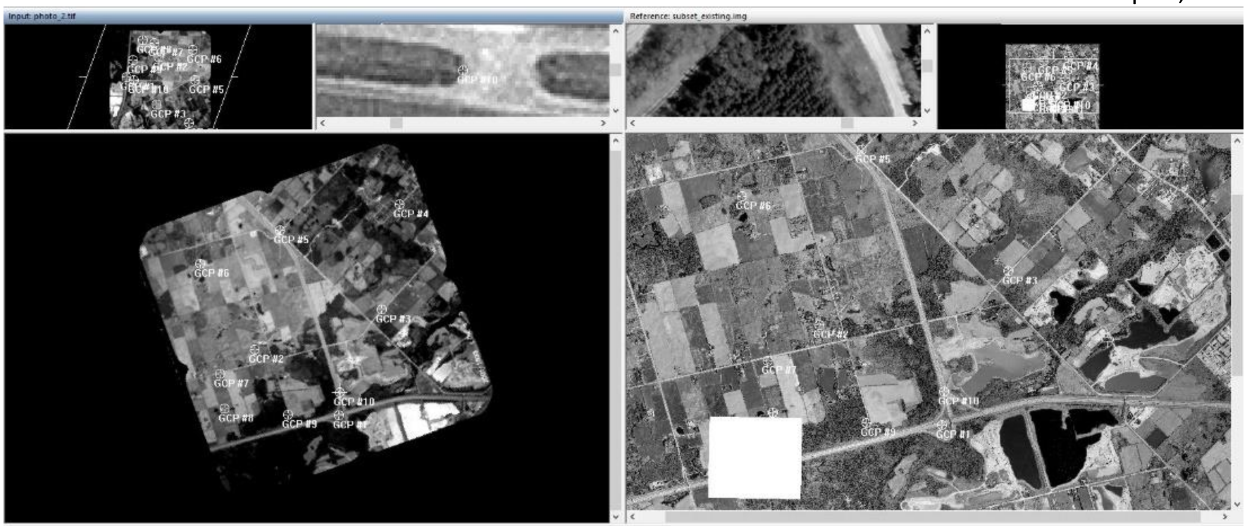

Figure 1 Using GCPs to match the feature locations in both imageries

While above procedure was done using the polynomial mode, same procedure was also done using camera mode with extra settings prior to choose the GCPs (Figure 2). Fiducial points, which are the fixed values as reference, were also inserted at the Model settings.

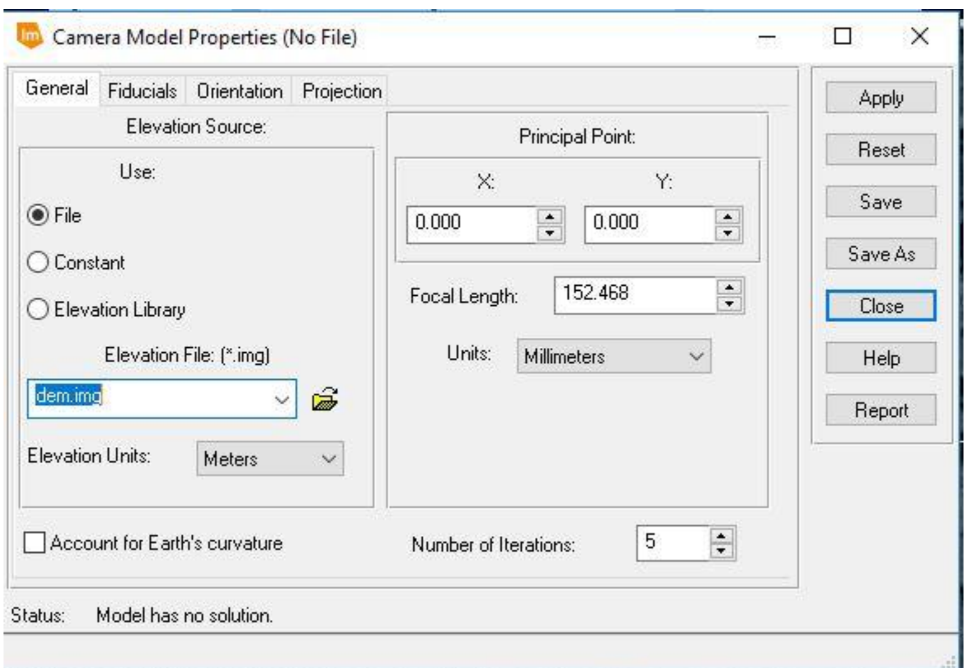

Figure 2 Settings prior to match GCPs

The photos were trimmed by drawing a polygon as Area of Interest to rem ove the black boarders of the aerial imageries. Afterwards the three imageries using the same model were combined using mosaic technique.

3.0 Result and Analysis

3.1 Polynomial

The following questions were answered based on the Geometric model results.

A. After entering 4 GCPs or more for your polynomial geometric correction, is the prediction process giving you a good localization of the GCP you enter? Explain why.

The predictions provided by the software after the 3rd GCP was entered generally located around the actual location which provided the general location where the GCP was on the other photo. However the predictions were not accurately located. The three GCPs provided the software a brief concept of the imageries based on the distance between the points and their neighboring pixel values. As the GCPs were applied by visualization, the same feature that is located on both imageries may not have same pixel values (or it could be the feature was covered in shadow on one of the imageries therefore pixel values are different as well. Also even the points seem to be at the same feature/location on both imageries, the distance between two points in the imageries may be different given the points were manually marked.

B. For each photo that will be geometrically corrected, take note of the total error of the "Control Point Error". Explain what is this error?

Point #	Point ID	>	Color	X Input	Y Input	>	Color	X Ref.	Y Ref.	Type	X Residual	Y Residual	RMS Error	Contrib.	Match
1	GCP #1			3.990	12.722			249918.808	4812163.195	Control	0.018	-0.004	0.018	0.834	
2	GCP #2			11.188	17.227			248601.032	4813238.374	Control	-0.015	-0.000	0.015	0.673	
3	GCP #3			10.716	6.667			250635.125	4813824.346	Control	0.004	0.006	0.007	0.323	
4	GCP #4			18.046	2.486			250956.415	4815478.961	Control	-0.018	0.020	0.026	1.215	0.392
5	GCP #5			19.381	12.135			249046.782	4815125.895	Control	0.003	-0.037	0.037	1.697	-0.092
6	GCP #6			19.023	18.967			247760.940	4814624.532	Control	0.029	0.012	0.032	1.454	0.144
7	GCP #7			10.284	20.474			248041.225	4812858.059	Control	-0.020	0.008	0.022	1.015	-0.643
8	GCP #8			7.585	21.111			248092.695	4812305.413	Control	-0.013	0.012	0.018	0.822	0.393
9	GCP #9			5.433	16.531			249104.209	4812192.268	Control	0.002	-0.009	0.009	0.416	0.592
10	GCP #10			5.673	12.037			249941.894	4812525.905	Control	0.011	-0.008	0.014	0.630	-0.558

Figure 3 Contol Point Error Data Using Polynomial Model

Figure 2 is the attribute table example of the attritbute table under the geometric model. Root-mean-square error (RMS error) indicates the distance difference between the location on the aerial photograph and the orthoimagery. All RMS error did not exceed 0.05 as the maximum error to ensure the output image would not be altered as much. The error value changes with more GCPs are added. The points were redone when the error exceed the maximum error.

C. During the creation of the resampled image, take note of the default pixel size of each output corrected photo. Is the pixel size of all the 3 corrected photos the same? Explain why. (Keep in mind that the photos have been acquired by the same sensor under the same conditions and at the same time)

The pixel sizes of corrected photo 1 and corrected photo 2 are 0.5 x 0.5; and photo 3 has 0.51x0.51 of pixel size. The pixel sizes of the three photos are very similar, which proves that photos the aerial photos were taken around the same time under the same flight.

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3.2 Camera

A. After entering 4 GCPs or more for your Orthorectification, is the prediction process giving you a good localization of the GCP you enter? Explain why.

The prediction did not show up after the fourth GCP was made unless the total button was pressed to calculate the errors. The prediction was more precise than the polynomial model. Wi5h setting up the parameters and fuducial points are more accurate on the GCPs.

B. For each photo to orthorectify, take note of the total error of the "Control Point Error". Is it the same as for the polynomial correction? Explain why?

Point #	Point ID	>	Color	X Input	Y Input	>	Color	X Ref.	Y Ref.	Z Ref.	Type	X Residual	Y Residual	RMS Error	Contrib.	Match
2	GCP #2			19.399	12.032			249065.208	4815135.440	340.097	Control	0.000	0.002	0.002	0.212	
3	GCP #3			17.132	18.969			247881.274	4814261.782	334.438	Control	-0.005	-0.008	0.010	1.104	
4	GCP #4			10.404	20.282			248067.198	4812892.038	330.036	Control	0.003	0.007	0.007	0.818	
5	GCP #5			7.805	21.353			248029.099	4812326.053	320.056	Control	0.002	-0.002	0.003	0.288	
6	GCP #6			4.142	12.134			250021.695	4812231.182	311.917	Control	-0.009	-0.000	0.009	0.980	
7	GCP #7			3.358	4.393			251522.872	4812583.677	311.166	Control	-0.015	-0.008	0.017	1.863	
8	GCP #9			9.102	7.289			250622.711	4813479.241	311.500	Control	-0.000	0.001	0.001	0.084	
9	GCP #10			10.737	6.670			250634.235	4813827.944	317.938	Control	0.000	0.004	0.004	0.418	
10	GCP #11			4.693	2.754			251740.287	4812941.812	314.247	Control	0.007	0.005	0.009	0.981	0.531
11	GCP #12			4.654	2.720			251748.397	4812937.659	314.065	Control	0.013	0.007	0.015	1.677	-0.391

Figure 4 Contol Point Error Data Using Camera Model

Figure 4 showed example of attribute table during photo 2 orthorectification. The RMS error is a lot lower compare to attribute table of the polynomial model, and that is because parameters were set before orthorecticifcation was performed. Setting parameters especially fudicial points provides a "border" as a reference of measurement. Distance measurement between each GCP was more accurately predicted with the parameter setting.

C. During the creation of the resampled image, take note of the default pixel size of each output orthophotos. Is the pixel size of all the 3 orthorectified photos the same? Explain why.

All pixel size of the corrected camera model photos are 0.50x0.50, therefore their pixel sizes are the same. The pixel sizes did not change during resampling process which means the content and shape of the resampled photos did not have any changes.

D. Check the quality of the orthomosaic. Overlay the vector files on the orthomosaic and check the overlay quality (buildings and roads). Is the shift between the vector files and the image less or more significant than in the first task. Compare the orthomosaic to the mosaic created in the first task.

With fewer values on RMS error result more accurate mosaic photo, the camera model resample photo would have less position shifts. By comparing the overlay quality from Figure 5 (polynomial) and Figure 6 (camera) the quality is very similar. Figure 9 showed a clear intersect between the two subset images. The road is slightly disconnected which showed there is slight difference in overlay.

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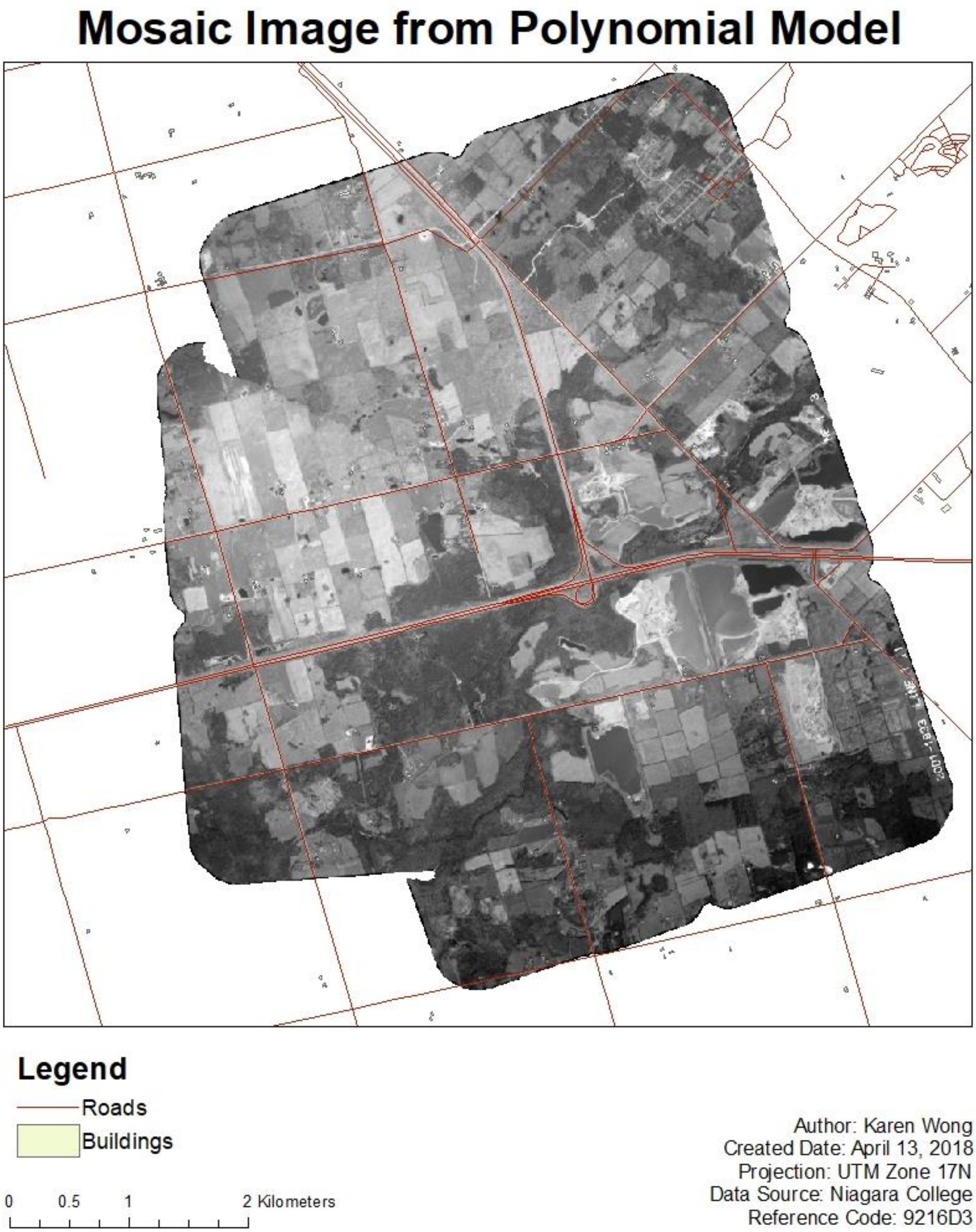

Figure 5 Resampled photo from polynomial model with roads and buildings shapefiles

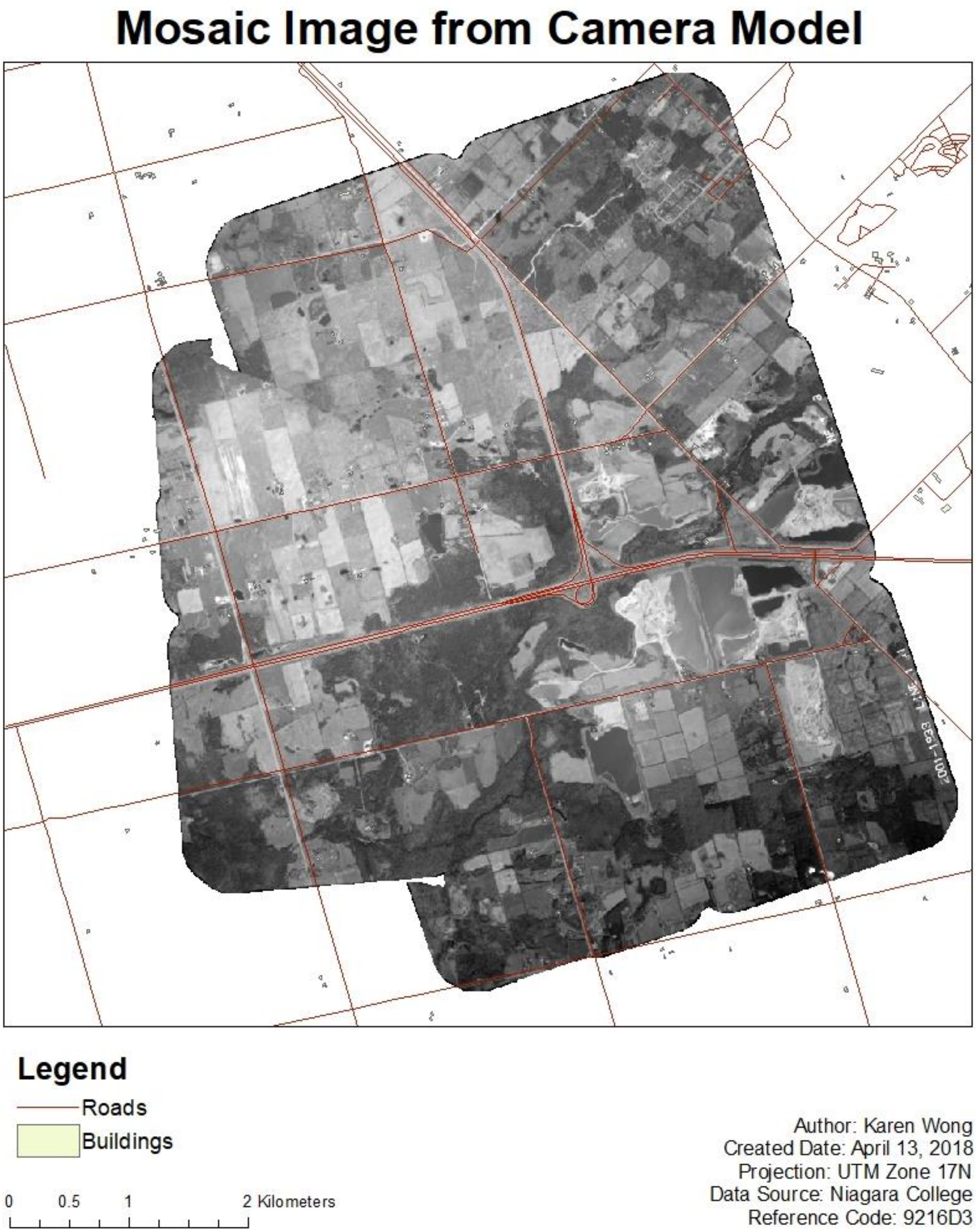

Figure 6 Resample photo from camera model with roads and buildings shapefiles

Figure 7 Intersection of the subet photos with polynomial model (left) and camera model (right)

4.0 Recommendation

While polynomial geometric model only uses GCPs to perform rectification as a simple process, camera model provides higher accuracy on the locations (lower RMS error values). However, when the mosaic image was zoomed into an area where the two original imgeries were intersected (Figure 7), the road is better connected on the polynomial model (left) than the right (camera model). Therefore the polynomial model looks more smooth on the mosaic images even thouogh the RMS error was higher.

5.0 Conclusion

Orthorectification assigns geographic coordinates on aerial photosgraphs to provide their exact locations by matching the feature on a georeeferenced subset image. There are different geometric models to connect the imageries. There are measurement errors that occur during rectification process. With the two geometric models that were used in this exercise, camera model produced less errors becase parameters were input before rectification. Therefore camera model provides more accurate result after mosaicking the imageries.