GEOMETRIC CORRECTION OF LANDSAT MSS IMAGERY

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ABSTRACT

Several LANDSAT scenes have been used to determine the image coordinates of the Geodetic Control Points with photogrammetric and pixel location methods. The criteria of control point rejection, method of transformation and accuracy results are discussed in details.

1. Introduction

The picture elements (pixels) being the natural units of LANDSAT MSS imagery their proper geometric characteristics is the major concern in information extraction and data handling. Geometric correction may be of primary importance in the case of mapping applications but also unavoidable in the majority of uses.

In this investigation the uncorrected (raw) data of nine images has been used to correct for systematic and nonsystematic distortions. Here only the results of one representative Perth image (1149-01370) will be published.

2. Control Point Identification and Measurement

Before the final location of control points, a preliminary identification has been carried-out to correlate image and map points because of the peculiar imaging process of the MSS. According to the results, the points have been marked and numbered on 1:250,000 LANDSAT imagery enlargements.

2.1 Photogrammetric measurement of Control Points

A Wild A7 Stereoautograph was used to determine the image coordinates of the control points. In a second step the image coordinates has been transformed into pixel locations of the original imagery.

2.2 Computer Aided Pixel Location of Control Points

The images have been subdivided into 5 segments. Initially for each image segment a histogram has been produced using the whole 64 radiance levels. To improve the information transfer a histogram equilisation was applied using only the 14 highest frequencies.

2.3 Map Coordinate Measurement of the Control Points

The map coordinates of the control points from the original 1:50,000 map series were digitized (Courtesy of the Department of Lands and Survey).

3. Geometric Correction

The approach to geometric correction was based on the nature of the LANDSAT data collection system where during the scanning process a number of systematic and nonsystematic geometric distortions are introduced.

3.1 Systematic distortions

The effects of this type of geometric distortions as:

(a) panoramic distortion,

(b) mirror velocity variations,

(c) scan skew, and

(d) earth rotation has been formulated and corrected before the nonsystematic distortion corrections.

3.2 Nonsystematic distortions

The geometric distortions introduced into a LANDSAT MSS imagery due to:

(a) orbital height variations,

(b) spacecraft attitude variations: pitch, roll, yaw and

(c) spacecraft velocity variations

are nonsystematic in nature and therefore cannot be formulated to produce acceptable accurate computational results. This distortions may be corrected by the use of ground control points. The nonsystematic distortions and transformation coefficients has been computed using third order polynomials as mathematical model.

4. Computation

Prior to computations the discrepancies were checked between the two independently determined imagery coordinates. Points with identification or measurement errors have been checked and remeasured or rejected.

With the retained control points computations were performed for the whole image and for each segment separately, for photogrammetric and pixel coordinates. In each case the standard errors for along track (σ_x) and across track (σ_y) with their resultant vector error (σ_r) has been derived.

For the rejection of observations the theory of "Student's Distribution" has been applied. As a criterion for the rejection of observations a probability level of 0.05 has been assumed, taking into consideration the largest expected error. The latter is based on the assumption that the most probable value is the true value and the mean square error is the true standard error. Bearing in mind that most probably no rejection criterion should be applied in a completely mechanical manner, the computations have been carried-out interactively. Observations lying well outside the usual range have been rejected (a further investigation is underway in respect of the outlier problems) but careful consideration has been taken in the case of residuals not large enough, bearing in mind that the inclusion of one slightly doubtful observation in a mean result is likely to cause less harm than the rejection of a very good observation.

5. Specifications and Results

In Table 1 and Table 2 the image definitions, number of used control points and the results are shown. It can be seen that the photogrammetric point measuring method produce slightly better results.

TABLE: 1 STANDARD ERRORS IN METERS ON THE GROUND DERIVED FROM THE CONTROL POINTS

IMAGE: 1149

IMAGE COORDINATES FROM PHOTOGRAMMETRIC MEASUREMENTS (A7)

IMAGE DEFINITION	NUMBER OF ITERATIONS															
	1st Iteration				2nd Iteration				3rd Iteration				4th Iteration			
	No of Points	σ_x	σ_y	σ_r	No of Points	σ_x	σ_y	σ_r	No of Points	σ_x	σ_y	σ_r	No of Points	σ_x	σ_y	σ_r
WHOLE IMAGE	144	112	96		133	54	39		121	43	37	57				
1ST SEGMENT	23	30	33	45												
2ND SEGMENT	26	39	125	130	27	34	28	44								
3RD SEGMENT	37	61	40		33	34	22	41								
4TH SEGMENT	27	111	102		19	32	21		18	19	22	29				
5TH SEGMENT	25	68	49		23	57	36		21	52	19					

TABLE: 2 STANDARD ERRORS IN METERS ON THE GROUND DERIVED FROM CONTROL POINTS

IMAGE: 1149

IMAGE COORDINATES FROM DATA EXTRACTION (CCT)

IMAGE DEFINITION	NUMBER OF ITERATIONS															
	1st Iteration				2nd Iteration				3rd Iteration				4th Iteration			
	No of Points	σ_x	σ_y	σ_r	No of Points	σ_x	σ_y	σ_r	No of Points	σ_x	σ_y	σ_r	No of Points	σ_x	σ_y	σ_r
WHOLE IMAGE	113	58	58		101	50	43		97	47	42		94	43	41	59
1ST SEGMENT	20	41	28		19	30	27	40								
2ND SEGMENT	26	47	158		22	56	95	110	18	39	27	47				
3RD SEGMENT	37	48	48		35	42	45		33	40	43	59				
4TH SEGMENT	26	53	35		22	31	27	41								
5TH SEGMENT	17	44	59		13	13	23	26								