HACETTEPE UNIVERSITY

GEOMATICS ENGINEERING DEPARTMENT

GMT346

REMOTE SENSING AND IMAGE PROCESSING

Assigment I

GeoCorrection

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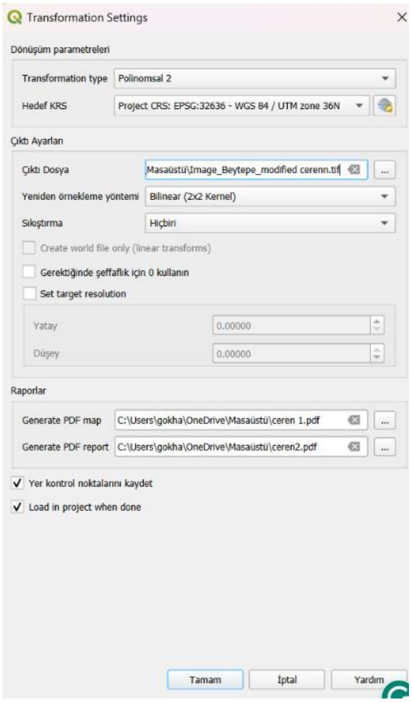
INTRODUCTION

We georeferenced the QuickBird satellite image of the Beytepe campus of Hacettepe University using the Georeferencer tool in QGIS within this project for delivering high positional accuracy for spatial analysis. With caution, we chose 16 ground control points (GCPs) from the reference file given to have both the corners of the image where the geometric distortions are usually maximum and central features of the campus. A second-order polynomial transformation (Polynomial 2) was applied to deal with global translations and local curvature. Bilinear interpolation with a 2×2 kernel was chosen to yield new pixel values for the trade-off between efficiency of computation and preservation of edge detail. The final GeoTIFF was reprojected to EPSG:32636 (WGS 84 / UTM Zone 36N), and black border pixels (value 0) were flagged as NoData and made transparent. The procedure produced a georeferenced image with an average RMS error of 0.124 pixels and a maximum residual error of 0.352 pixels (at GCP #7), as confirmed by overlay comparison to reference basemaps.

Q1) Which resampling method did you choose? Why ?

In thıs study, we applied the bilinear interpolation algorithm with a 2×2 kernel because it computes each output pixel value as a distance-weighted average of its four closest neighbors. It smoothes transitions between pixels without generating the blocky artifacts inherent in nearest-neighbor resampling, and does so with significantly less computational overhead than cubic or spline-based algorithms. In our app, bilinear interpolation maintained the acuity of fine features such as building walls and road borders, without detriment to the swift processing of immense QuickBird collections. Bilinear interpolation also suppresses high-frequency noise and aliasing and yields more visually homogenous mosaics when joining many tiles together.



Q2) What is the average RMS error value of the GCPs?

The root-mean-square (RMS) error computed across all 16 GCPs is 0.124 pixels. RMS error quantifies the average spatial difference between the image coordinates following transformation and their real ground equivalents by computing the square root of the mean of squared residuals. A sub-pixel RMS error indicates that on average, every GCP is a fraction of a pixel away from its true location, showing exceptional georeferencing precision. In remote sensing, an RMS error of below 2 pixels would generally be acceptable for high-resolution images; our result of 0.124 pixels indicates that the transformation parameters and point placement achieved almost ideal alignment.

Dönüklük 0.0° Dönüşüm:Polinomsal 2 Ortalama hata: 0.124026 1225.3,-1551.6 Hiçbiri

Q3) Which GCP contributed the largest RMS error and what is its value?

Maximum residual error of 0.352 pixels at GCP #7, positioned on the northern border of a wide field lying alongside dense plantation of trees and narrow unpaved road. The tree shadows and their related colour and texture of the field boundary reduced local contrast, which made it hard to determine the exact control feature in the QuickBird image and reference basemap. The vagueness in manual digitization led to the small offset. Despite this, a difference of pixels still provides sub-pixel accuracy; however, shadowed or low-contrast areas should be circumvented for GCP positions to reduce residual errors further.

dX = -0.192211 pixels

dY = -0.0331135 pixels

YKN tablosu

Etkinleştir	ID	X kaynağı	Y kaynağı	X Mesafesi	Y Mesafesi	dX (Pikseller)	dY (Pikseller)	Residual (Pikseller)
✓	0	817.823030	-425.542014	477091.52	4415444.12	0.069859	-0.010913	0.070706
✓	1	893.288202	-670.275067	477136.56	4415296.58	-0.007483	0.000660	0.007512
✓	2	364.273298	-973.814206	476812.29	4415113.36	-0.055669	-0.038113	0.067466
✓	3	499.145627	-2116.9535	476890.22	4414424.94	-0.008186	-0.003026	0.008728
✓	4	1222.4455	-2502.9153	477332.40	4414193.88	0.037680	0.018376	0.041923
✓	5	1945.5873	-2473.5947	477763.15	4414212.64	-0.163531	-0.041462	0.168706
✓	6	1943.3995	-2522.8686	477762.10	4414183.03	0.057333	-0.010879	0.058356
✓	7	1519.6325	-2254.2873	477510.95	4414343.75	-0.029568	-0.007092	0.030407
✓	8	1735.6616	-1873.7393	477638.78	4414572.70	0.207598	0.098693	0.229863
✓	9	1568.6406	-1074.3580	477539.10	4415053.54	-0.029445	-0.045469	0.054170
✓	10	1572.5508	-709.300498	447542.22	4415272.62	0.000020	0.000020	0.000028
✓	11	1618.5421	-711.455092	477567.89	4415272.06	-0.001108	0.004054	0.004202
✓	12	1649.0522	-476.763858	477585.33	4415413.48	0.053664	-0.048801	0.072536
✓	13	1208.2115	-464.634287	477325.40	4415420.60	0.002630	0.069180	0.069230
✓	14	1132.7209	-471.390671	477280.47	4415416.52	0.058417	0.047886	0.075536
✓	15	1512.9670	-686.318153	477505.72	4415287.18	-0.192211	-0.033113	0.195043

ID	Etkin	Pixel X	Pixel Y	Map X	Map Y	Res X (Pikseller)	Res Y (Pikseller)	Res Total (Pikseller)
0	evet	818	-426	477091.520	4415444.120	0.0698585	-0.0109134	0.0707059
1	evet	893	-670	477136.560	4415296.580	-0.00748318	0.000660155	0.00751224
2	evet	364	-974	476812.290	4415113.360	-0.0556688	-0.0381129	0.0674656
3	evet	499	-2117	476890.220	4414424.940	-0.00818616	-0.00302635	0.00872765
4	evet	1222	-2503	477332.400	4414193.880	0.0376805	0.0183763	0.0419226
5	evet	1946	-2474	477763.150	4414212.640	-0.163531	-0.0414621	0.168706
6	evet	1943	-2523	477762.100	4414183.030	0.0573334	-0.010879	0.0583565
7	evet	1520	-2254	477510.950	4414343.750	-0.0295682	-0.00709192	0.0304068
8	evet	1736	-1874	477638.780	4414572.700	0.207598	0.0986929	0.229863
9	evet	1569	-1074	477539.100	4415053.540	-0.029445	-0.045469	0.0541705
10	evet	1573	-709	447542.220	4415272.620	1.98412e-05	2.01424e-05	2.82735e-05
11	evet	1619	-711	477567.890	4415272.060	-0.00110807	0.00405374	0.00420246
12	evet	1649	-477	477585.330	4415413.480	0.0536644	-0.0488013	0.0725358
13	evet	1208	-465	477325.400	4415420.600	0.00263049	0.0691803	0.0692303
14	evet	1133	-471	477280.470	4415416.520	0.0584171	0.0478859	0.0755355
15	evet	1513	-686	477505.720	4415287.180	-0.192211	-0.0331135	0.195043

Q4) What is the required minimum number of GCPs fort he 2nd order plynomial function? Justify your answer by writing the 2nd order polynomial tranformation functions?

What is the minimum number of GCPs required for a second-order polynomial transformation, and what are the transformation equations?**A second-order polynomial transformation involves six coefficients per coordinate equation, so at least six GCPs are required to solve the system. The transformation equations are:

$$X' = a_0 + a_1 \cdot X + a_2 \cdot Y + a_3 \cdot X^2 + a_4 \cdot X \cdot Y + a_5 \cdot Y^2$$

$$Y' = b_0 + b_1 \cdot X + b_2 \cdot Y + b_3 \cdot X^2 + b_4 \cdot X \cdot Y + b_5 \cdot Y^2$$

(X, Y) here are the original image pixel coordinates, and (X′, Y′) are target CRS map coordinates. Six GCPs are sufficient to determine coefficients, but we used 16 points for overdetermining the system and improving robustness with least-squares fitting and distributing residual errors more evenly across the image. This redundancy makes one more confident in the stability of the transformation, especially when dealing with complex terrain.