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Geometric correction for satellite image of Mosul city using 3D methods

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ABSTRACT

The important preprocessing techniques for remote sensing data and geometrical alteration is the geometric correction. In this paper ,it covers two models which are used in to three dimensions the physical model and the projective Transformation for SPOT 2 to determine the geometric correction of study region of Mosul city. The ground control points are located on SPOT 2 satellite image. These models are producing the X residual, Y residual and root mean square error (RMSE) and then comparing the effects of two models. The X residual for SPOT 2 physical model is lower than X residual for projective transformation at 0.1420, while the Y residual for physical model has higher comparing with Y residual for projective transformation at 0.1143and Total RMSE for SPOT 2 physical model is lower than Total RMSE for projective Transformation at 0.1823. The physical model is superior to Projective model, so that, it is highly recommended to be used for very precise application and not to be replaced by these non-physical models. For the physical model, it is clearly that, the altitude of the Ground Control Points (or Check Points) does not effect on its individual RMSE, when using Projective model the RMSE for high altitude was high ,where at low altitude it was low too(extreme relationship).

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التصحيح الهندسي لصورة القمر الصناعي لمدينة الموصل باستخدام الأساليب ثلاثية الأبعاد

أسراء حسين **نوال خلف غزال**

قسم الفيزياء ،كلية العلوم ،جامعة بغداد ، بغداد العراق

الـــخُـــلاصـــة

أن تقنيات المعالجة المسبقة الهامة لبيانات الاستشعار عن بعد والتغيير الهندسي هي التصحيح الهندسي. يغطي هذا البحث نموذجين يستخدمان في ثلاثة أبعاد: النموذج المادي والتحول الإسقاطي لـ SPOT 2 لتحديد التصحيح الهندسي لمنطقة الدراسة في مدينة الموصل. توجد نقاط التحكم الأرضية على صورة القمر الصناعي SPOT 2 .تنتج هذه النماذج الخطأ X

الكلمات المفتاحية:

SPOT2
النموذج المادي
نموذج التحويل الإسقاطي
X المتبقية
Y المتبقية
RMSE
مدينة الموصل.

المتبقي ، والمتبقي Y والمتوسط الجذري للخطأ التربيعي (RMSE) ثم مقارنة تأثيرات نموذجين. المتبقي X للنموذج المادي SPOT 2 أقل من المتبقي X للتحويل الإسقاطي عند ٠.١٤٢٠ ، في حين أن المتبقي Y للنموذج المادي أعلى مقارنة بـ Y المتبقي للتحويل الإسقاطي عند ٠.١١٤٣ وإجمالي RMSE للنموذج المادي SPOT 2 أقل من إجمالي RMSEللتحول الإسقاطي في٠.١٨٢٣.

. يتفوق النموذج المادي على النموذج الإسقاطي ، لذلك يوصى بشدة باستخدامه للتطبيق الدقيق للغاية وعدم استبداله بهذه النماذج غير المادية. بالنسبة للنموذج المادي ، من الواضح أن ارتفاع نقاط التحكم الأرضية (أو نقاط الفحص) لا يؤثر على RMSEالفردي ، عند استخدام نموذج الإسقاط ، كان RMSEللارتفاعات العالية مرتفعًا ، حيث كان منخفضًا أيضًا على ارتفاع منخفض (علاقة متطرفة).

1. INTRODUCTION

When using remote sensing information with the external and the internal distortions corrected by measured. The internal distortions are mistake that occur in the sensors. These are measured as systematic errors and can be removed using a mathematical correction model. External distortions occur as a result of deviancy of the sensing system. The changes in the topography and atmosphere of the earth are the errors and can be removed by using control points that appear in the image [1].

Remote sensing data is using some methods and additions. All these systems have errors of the method of data group. The preprocessing of the remote sensing data to the start of the analysis process to remove the errors. The method of image restoration is practical to remove distortion, alteration and reduction of noise which related of image processing. The image reparation process products a corrected image that oppositions as possible with the original image from radiological perception and geometrical [2],[3]. In this paper, two models were used for transformation joint with a number of ground control points. These models are physical model of SPOT2 and Projective transformation model. The SPOT satellite with 10m pixel size and stereo viewing competence offers a tool for mappers with greater potential than other civilian remote sensing satellite, it is accuracy of the order of 0.5 to 1 pixels are obtainable from scanned remote sensing imagery. It was anticipated that positional accuracies of the order 5 to 10 m RMSE might be achieved in mapping from panchromatic SPOT imagery ,this well within 1:50000 mapping specifications [٤].

While topographic feature for the map scale of 1:100000 can mostly and the the feature for the map with scale of 1:50000 can patially be extracted from SPOT satellite images [5],[6].

2. Models of geometric correction

2-1 SPOT2 physical model

The physical model contains the ortho rectification procedure rather than simple geometric correction, according to this process; the geometric errors basic within imagery and photography are to be removed. The variables donating to geometric errors contain, but are not incomplete camera and sensor orientation, Systematic error associated with the camera or the sensor, Topographic relief displacement and Earth curving. Each sensor has individual unique features, one can draw generalizations for the growth of 2D/3D physical models, for completely correct all the earlier described distortions[7]. The physical model should mathematically model all alterations of the platform (location, velocity, and attitude), the

sensor (viewing angles, panoramic effect), the Earth (ellipsoid and relief for 3D) and the cartographic prediction.

The geometric correction procedure can statement each distortion step by step and one by one or concomitantly[8]. It is better to consider the total geometry of viewing (Platform + sensor + Earth + map), because several of their distortions are connected and have the same kind of effect on the ground. It is theoretically more exact to compute one [9].

2-2 Projective Transformation

Projective model rapid the connotation between two spaces based on viewpoint estimate conceptions. These two spaces are clear in the work as image space and the ground space .The two-dimensional projective coordinate transformation is also recognized as the eight-parameter transformation. In their last form, the two-dimensional projective coordinate transformation equations are:

$$x=a1+a2X+a3Ya7X+a8Y+1\ldots\ldots \quad (1)$$

$$y=a4+a5X+a6Ya7X+a8Y+1\ldots\ldots\ldots \quad (2)$$

Where (a1, a2, a3, a4, a5, a6, a7, and a8) are the eight unknown parameters of the functions, (x, y) are the image coordinates and (X, Y) are the earth coordinates [10].

3.Study aera

Study aera concederd in the north of Iraq which is enclosed by SPOT 2 index 277J 132 K , PANwith GRS with level A1 at (latitude 37 N, longitude 168 E),contain Mosul city with its surrounded regions .as shwon as in figure (1). The Ground control points GCPs taken by using GPS diveice as showing in table (1) .Where the green and yallow points are cheack points(accurcy type of GCPs)and red points are the control points.

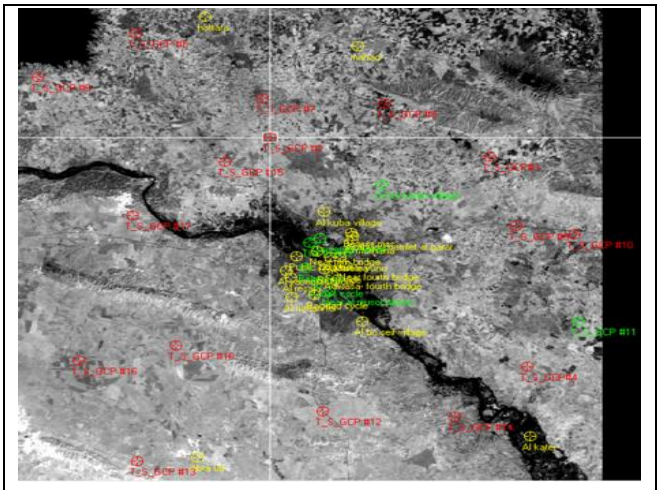

Figure 1: The study region of Mosul city with surrounded regions with GCPs

4. Conclusion

Table(1):The GCPs points from GPS and their positions for Mosul city.

GCP-ID	X-Reference (m)	Y-Reference (m)	Z-Reference (m)
T_S_GCP #2	331819.05	4040444.19	277
T_S_GCP#3	353442.8	4032987.9	324
T_S_GCP#4	349883.5	4006394.1	276
T_S_GCP #5	321904.7	4056276.3	362
T_S_GCP #6	310659.1	4053161.6	375
T_S_GCP #7	332450.8	4045426.2	323
T_S_GCP #8	344498.1	4041962.9	333
T_S_GCP #9	353698.8	4023897.9	279
T_S_GCP #10	359335.8	4021518.9	293
T_S_GCP #11	356722.8	4010798.1	257
T_S_GCP #12	327595.1	4005642.3	311
T_S_GCP #13	307075.9	4003821.5	337
T_S_GCP #14	340791.1	4001953.9	222
T_S_GCP #15	326392.2	4038511.1	289
T_S_GCP #16	304767	4017490.9	334
T_S_GCP #17	315262.1	4033988.6	252
T_S_GCP #18	314999.1	4017115.9	340
Near al musol airport	332473.58	4020195.89	224
Al resala	329017.89	4022826.74	244
The forests	332131.07	4026587.83	216
Al faisalea	333755.82	4024385.51	212
Al muthana	336574.61	4026017.9	222
Right side	332712.35	4023004.75	212
Al nabi yunis	334672.7	4024208.39	213
Public hospital	330302.37	4025307.13	241
Bab singar	330887.45	4023634.21	228
Adwasa- fourth bridge	333266.59	4022093.17	211
Azahuor-hamlet al garar	336826.98	4026489.8	229
Asuas cycle	331478.61	4021557.19	221
Al yarmouk cycle	328795.89	4023706.03	257
Bagdad cycle	330773	4020111.36	254
Beauty mss	336680.47	4026911.72	234
Near fifth bridge	332622.14	4025444.97	213
Near fourth	335051.36	4022877.37	210

bridge			
University tunnel	333315.72	4026939.26	216
Al bo seif village	334696	4015826	252
Al ruman tal	328404	4020342	277
Al kuba village	334705	4030127	266
Orta kharab village	341495	4032070	269
hattara	329468.4	4056740	354
Abta tal	313306.8	4002864.6	290
Al kater	347744.2	3997820.1	194
mahad	343838.5	4049584.5	339

4.Results and Discussions

The physical model and the Projective Transformation (non-physical model) for geometric correction of satellite or aerial images have been implemented, resulting different parameters, i.e. individual X-Residual, individual Y-Residual, individual RMSE (for each GCPs) for these two methods calculated and shown in table (2) . While the Total X-Residual , Total Y-Residual and Total RMSE (for overall GCPs) have been calculated as shown in table (3) .Figures (2) and (3) show that the corrected satellite image that is using method based on SPOT2 Physical model and projective model respectively appear the same because of the resampling process is not including any significant enlargement. The resulted geometric corrected image (from any of the techniques of the resampling process: nearest neighbor, bilinear, cubic spline) seems (visually) to be the same for any of the adopted transformation model. but the result of X-Residual and Y-Residual of Projective model was deflect at a negative value, thus ,some estimates of a positive variance component can be negative because one random term is subtracted from another as shown as in figure (4) shows comparing results between the two models.

Table 2: Individual Residuals and RMSE for the GCPs, using models SPOT2of physical and projective Transformation.

	SPOT2of physical			**projective Transformation**		
GCP-ID	X-Residual (Pixel)	Y-Residual (Pixel)	RMSE (Pixel)	X-Residual (Pixel)	Y-Residual (Pixel)	RMSE (Pixel)
T_S_GCP #2	-0.034	0.136	0.141	X-Residual	Y-Residual	RMSE
T_S_GCP#3	-0.092	0.012	0.093	-0.935	0.892	1.292
T_S_GCP#4	0.22	-0.083	0.235	-0.384	-3.436	3.457
T_S_GCP #5	-0.241	0.162	0.290	1.094	4.192	4.333
T_S_GCP #6	0.047	0.034	0.059	0.577	3.929	3.971
T_S_GCP #7	-0.112	0.123	0.167	6.739	4.328	8.009
T_S_GCP #8	-0.157	0.145	0.214	-1.692	0.416	1.742
T_S_GCP #9	0.001	-0.077	0.078	-2.173	-2.534	3.338
T_S_GCP #10	0.028	-0.102	0.106	2.037	-1.216	2.372
T_S_GCP #12	0.0004	-0.05	0.048	3.579	-1.174	3.767
T_S_GCP #13	-0.369	0.183	0.412	-4.434	2.264	4.979
T_S_GCP #14	0.175	0.213	0.276	-0.906	-1.398	1.666
T_S_GCP #15	0.0487	0.0527	0.072	0.975	3.229	3.373
T_S_GCP #16	0.0472	0.0956	0.107	-0.495	0.716	0.870
T_S_GCP #17	0.205	-0.358	0.412	4.471	-2.995	5.381
T_S_GCP #18	0.057	-0.109	0.123	2.140	-0.088	2.142
Al resala	-0.095	0.0247	0.098	-0.234	-1.210	1.232
Al faisalea	0.0007	0.012	0.013	-1.262	-0.775	1.481
Al muthana	0.062	0.006	0.063	-0.016	-0.565	0.566
Right side	-0.017	0.0129	0.0214	0.185	-0.428	0.467
Al nabi yunis	0.023	0.009	0.024	-0.212	-0.696	0.728
Public hospital	-0.084	0.027	0.089	0.087	-0.544	0.551
Adwasa- fourth bridge	-0.001	0.008	0.009	-1.015	-0.597	1.177
Azahuor- hamlet al garar	0.066	0.0055	0.067	-0.146	-0.715	0.730
Al yarmouk cycle	-0.107	0.028	0.111	0.017	-0.429	0.429
Bagdad cycle	-0.046	0.009	0.048	-1.477	-0.697	1.633
Beauty mss	0.06	0.006	0.061	-1.652	-0.602	1.758
Near fifth bridge	-0.03	0.019	0.036	-0.154	-0.429	0.456
Near fourth bridge	0.0358	0.005	0.036	-0.151	-0.522	0.543
Al bo seif village	0.0297	-0.018	0.035	0.197	-0.598	0.629
Al ruman tal	-0.091	0.017	0.093	-1.560	-0.006	1.560

Al kuba village	-0.004	0.015	0.016	-2.164	-0.578	2.240
hattara	0.212	-0.275	0.347	-1.180	-0.443	1.261
Abta tal	0.362	-0.22	0.423	-1.181	2.084	2.396
Al kater	-0.328	-0.013	0.328	-2.296	-1.705	2.859
mahad	0.126	-0.06	0.14	5.406	4.742	7.191

Table 3: Total Error for the GCPs, using SPOT2 Physical Model and projective Transformation.

	SPOT2 Physical	projective Transformation
X-Residual (Pixel)	**0.1420**	**-1.785**
Y-Residual (Pixel)	**0.1143**	**-2.410**
Total (Pixel)	**0.1823**	**2.999**

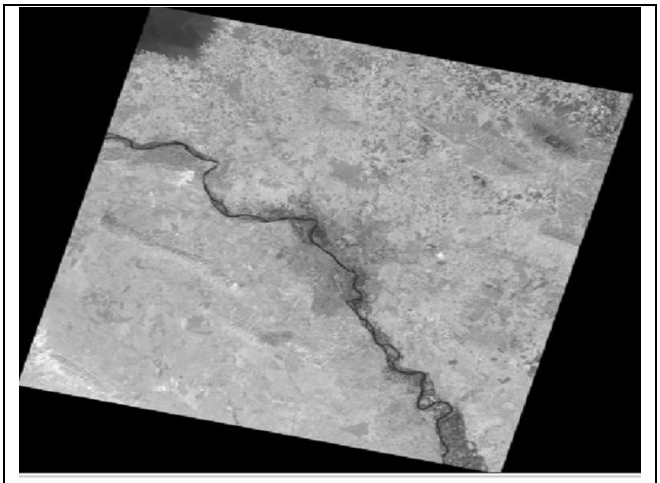

Figure 2: The corrected satellite image using method based on SPOT2 Physical model.

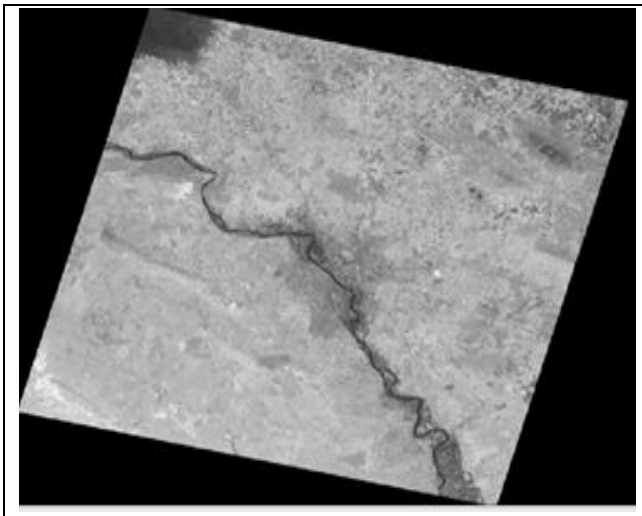

Figure 3:The corrected satellite image using method based on projective model.

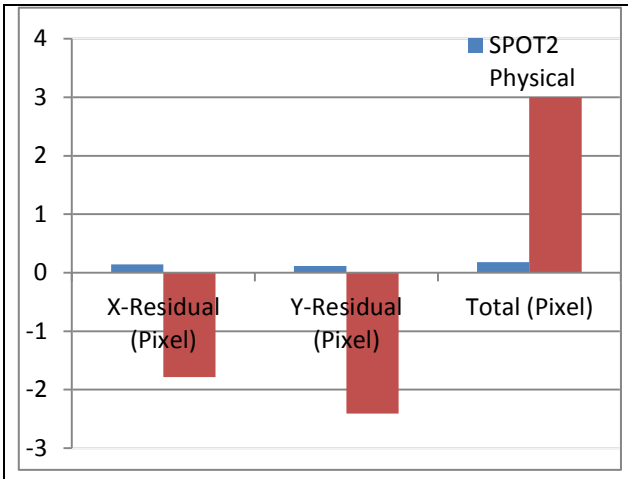

Figure 4: show comparing between the using two models.

5. Conclusion

The physical model is superior to Projective model, so that, it is highly recommended to be used for very precise application and not to be replaced by these non-physical models.

For the physical model, it is clearly that, the altitude of the Ground Control Points (or Check Points) does not effect on its individual RMSE, when using Projective model the RMSE for high altitude was high ,where at low altitude it was low too(extreme relationship).

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