

USING RTK GPS METHOD IN CREATION OF DIGITAL TERRAIN MODELS

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Abstract

Digital Terrain Model (DTM) is a solution method in earth surface's characteristics and appearance's projection. DTM explain the terrain surface as a 2D function. DTMs are utilized in engineering studies like city planning, defence, transportation and natural hazard risk management. To creation a DTMs, terrain's elevation data (Digital Elevation Model) are needed. This information is obtained by photogrammetry, digitizing, laser scanning, radar interferometry, classical survey and RTK GPS methods.

In this study, RTK GPS data is compared to classical survey data. Therefore, digital elevation models are constituted from 3D coordinates of the terrains, which are obtained by each two methods. In study area, selected cross section controls are performed with 5 meter difference at various directions and the results are compared. Except the study area's sides and the parts, which didn't indicate smooth variation, the results are rather closer to each other. RTK method's using is recommended for survey method straightness, time possession and economy in suitable terrain structures for GPS surveys.

1. INTRODUCTION

Digital Terrain Model (DTM) is three-dimensional show of surface. Not only coordinates and altitudes but geographical and natural characters in surfaces should be known for this show. Land modelling is made definition, sensing and application in land. Appropriateness of DTM to topography depends on based gathering of base points which model is based on sufficient frequency and feature. Base points could be determined by various measurement methods. Real Time Kinematic (RTK) GPS is one of these methods. RTK GPS having broad use, is used in mapping, improvement applications, canal and pipeline projects, car trace system, road construction applications. Instant and definite measurements could be obtained when RTK GPS method is used detailed points constituting of DTM could be measured more swiftly and truly than classical measurements.

2. DIGITAL TERRAIN MODEL

DTM is the solution model in showing of land characters and appearances. DTM aims of evaluating data collected from land surface in computer. DTM first appeared in 1950 to use for using calculation of width and length appearance, volume in road project and applied for models including latitude data. Later in addition to latitude data, it was understood that it is necessary to evaluate natural and artificial details of land in DTM.

Arslanoglu and Ozçelik (2005) pointed out that DTM is the model representing ground surface, having latitude data of irregular scattered critical points.

With developing computer technology, DTM have also been using in many areas such as industry, medicine, architecture, mining, agriculture, mapping (Maras, 1993&Habib, 2005).

These fields,

- Planning of transportation and optimization of transportation
- Planning of irrigation and drainage work
- Analyse of communication network
- Planning of dam area
- Planning of measurement network
- Land information system
- Navigation and direction
- City and region planning
- Disaster emergence planning
- Erosion control
- Evaluation of mining reserves
- Planning of use of weapon system
- Determination of radar cover area
- Three-dimensional city modelling
- Digital orthophoto map production

The purpose of DTM is to represent to topographic surface by mathematical described surface. For this reason, it is necessary to determine base points described with three-dimensional coordinates in topographic surface. Frequency and distribution of base points are essential to conform suitability of DTM to topography. Heights of new points in topographic surfaces are obtained via base points. Surface interpolation model is used calculation of height of new points. Confirmation of height data depends on interpolation technique used progresses related to DTM are evaluated in three groups.

- Collecting of data
- Evaluation of data collected
- Presentation of data (Yıldız, 1992).

Necessary data to create DTM are,

- Data collecting with classical measurements
- Data collecting with photogrammetric measurements
- Scanning of topographic maps and plans and digitized

Electronic distance measurements, level and GPS are used in classical method. Digital evaluation operator collect critical land details via streomodel in photogrammetric method. Contour lines and other details are digitized in digitization of maps and plans existed.

Recently, laser scanning and radar interferometry methods are also been used to collect necessary data in creating of DTM (Chang, 2004).

3. REAL TIME KINEMATIC GPS

Determination of position by GPS, depending upon determination of satellite-receiver distance is solution of problems from space. Main process in GPS receiver is recording of signals coming from all directions and calculation of distance of satellite-receiver (Kahveci&Yıldız, 2001).

Long observations on first use of phase measurements made for static positioning were made to reach desired accuracy. In sufficient number of GPS satellite in orbit, modelling mistakes caused time elapsing studies aimed to make GPS measurements more efficient resulted in new measurement methods (Mekik&Arslanoglu, 2003).

RTK GPS is one of these techniques, with this method data in centimetre accuracy could be simultaneously obtained. Double frequencies GPS receives are used on both reference and rover stations in RTK GPS methods. In this method, different from static and cinematic GPS methods, some additive devices are needed. Radio transmitter broadcasting

transporters wave phase measure corrections, calculated in base station and radio receiver receiving these corrections in rover station are used.

The more satellite observe reference and rover receivers, the more whole number fixing progress is accelerators and position accuracies increases (Sickle, 2001).

Advantage of RTK GPS to other GPS methods,

- Later calculation free
- In case of determination of well-known points (three points) in study area, the other points could be converted simultaneously to local coordinate system
- Correct measurement warranty is possible
- Coordinate known points make sensitive navigation and application.
- With this method, GPS receivers could be used as electronic tacheometer (Mekik&Arslanoglu, 2003).

RTK GPS is accepted in all over the world. Due to sensitive use (horizontal ± 2 cm, vertical ± 4 cm), it is used in many geodetic studies such as, cadastre studies, reconstruction plan applications, mapping, mine survey and photogrammetry.

More sensitiveness and easy measurements in RTK GPS increased its use in mapping studies. Especially, it's more frequently used in determination of detail points application studies.

4. STUDY AREA AND MEASUREMENTS

Sahitler Hill, close to Kocatepe University Campus (Afyonkarahisar/Turkey) was selected as study area. The study area is approximately 50.000m² and average elevation is 1036 m above the sea level (Figure 1). Regular grids in 2 m intervals were created for making surface measurements. X, Y and Z coordinates of grid points were determined by Zeiss Elta RS 45 (± 3 mm+3ppm) electronic distance measurement and Pentax AL-320 (± 0.8 mm/km) level. Points in where coordinate and height is known were considered as reference station by RTK GPS method. Study area was combed by rover station and special points and detailed points were measured in 5 m intervals. Once reference station coordinates depend on local coordinate system, coordinates of points determined were obtained in same system.

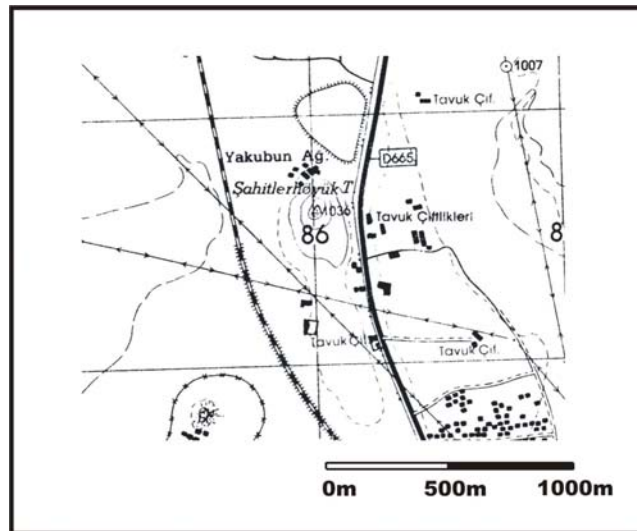


Figure 1. Sahitler Hill

5. APPLICATION

DTM of study area with Kriging interpolation technique was obtained via classical measurements and RTK GPS method (Figure 2).

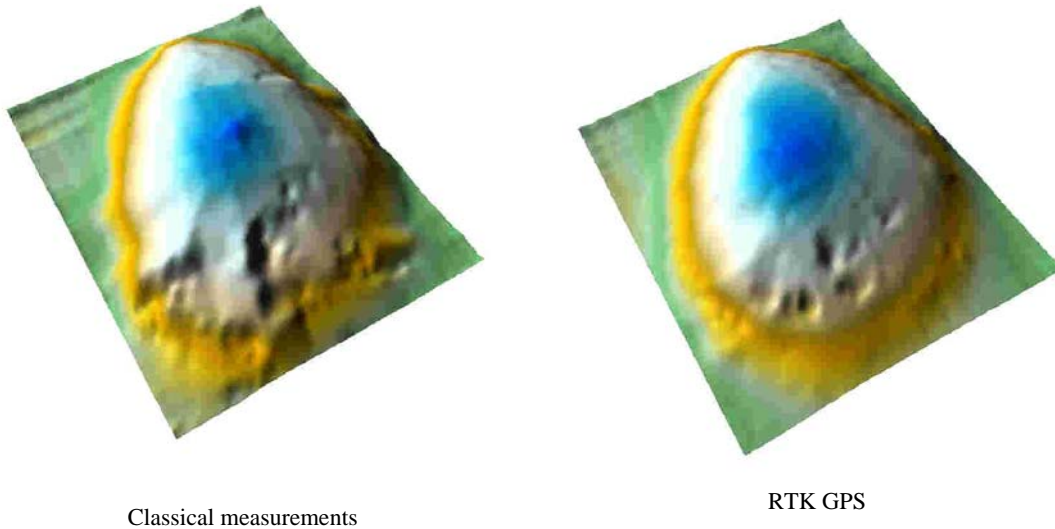


Figure 2. DTM obtained from classical measurements and RTK GPS

Show of study area with contour lines by classical measurements and coordinates obtained from RTK GPS method was given Figure 3.

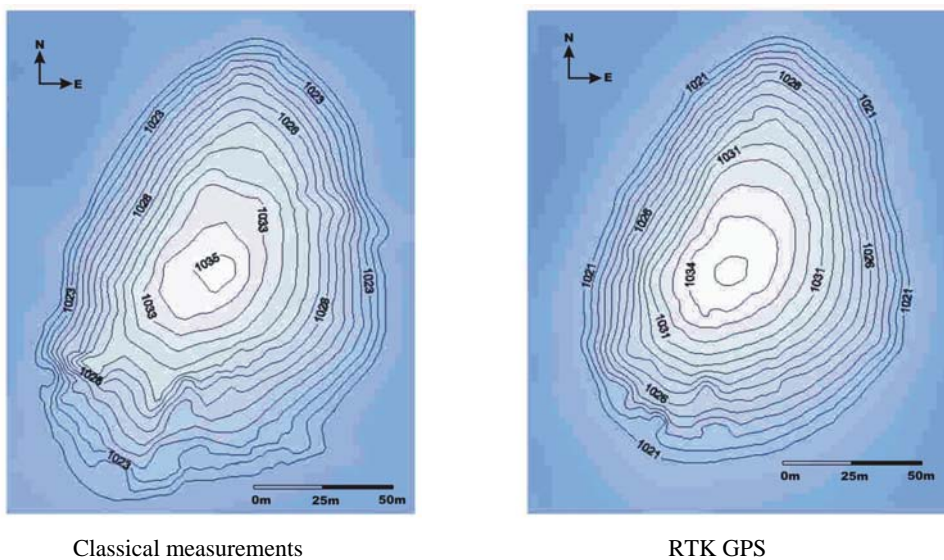


Figure 3. Contour lines obtained from classical measurements and RTK GPS

Cross section passing over the highest point of Sahitler Hill in West-East and South-North directions was created and points were determined in 5 m intervals for observing usability of RTK GPS instead of surface measurements in determination land topography. Heights of these points determined according to contour lines in Figure 3 were created by interpolation. These values and differences were given in Table 1. Changes on heights in cross sections according to both methods were give in Figure 4 and 5.

Table 1. Heights of points in cross sections

WEST - EAST				SOUTH - NORTH			
Point	Classical (m) I	RTK GPS (m) II	I-II (m)	Point	Classical (m) I	RTK GPS (m) II	I-II (m)
1	1023.05	1022.66	0.39	1	1021.96	1021.64	0.32
2	1024.70	1024.55	0.15	2	1022.93	1022.69	0.24
3	1027.50	1027.36	0.14	3	1024.11	1023.99	0.12
4	1029.11	1028.99	0.12	4	1025.33	1025.15	0.18
5	1030.65	1030.78	-0.13	5	1026.03	1025.95	0.08
6	1032.00	1032.16	-0.16	6	1026.78	1026.70	0.08
7	1032.95	1033.05	-0.10	7	1027.50	1027.55	-0.05
8	1034.06	1034.09	-0.03	8	1028.55	1028.68	-0.13
9	1034.45	1034.52	-0.07	9	1029.97	1030.13	-0.16
10	1034.95	1035.03	-0.08	10	1031.00	1031.12	-0.12
11	1035.11	1035.10	0.01	11	1032.03	1032.21	-0.18
12	1034.30	1034.18	0.12	12	1033.11	1033.13	-0.02
13	1033.45	1033.53	-0.08	13	1033.80	1033.84	-0.04
14	1032.66	1032.77	-0.11	14	1034.61	1034.48	0.13
15	1031.90	1031.90	0.00	15	1035.04	1035.01	0.03
16	1031.05	1030.98	0.07	16	1035.03	1034.91	0.12
17	1030.00	1029.83	0.17	17	1034.67	1034.63	0.04
18	1028.80	1028.62	0.18	18	1034.33	1034.35	-0.02
19	1027.20	1027.16	0.04	19	1033.91	1033.95	-0.04
20	1025.65	1025.73	-0.08	20	1033.66	1033.50	0.16
21	1023.99	1024.06	-0.07	21	1033.34	1033.19	0.15
22	1022.21	1022.11	0.10	22	1032.80	1032.69	0.11
				23	1032.06	1031.94	0.12
				24	1031.36	1031.27	0.09
				25	1030.35	1030.36	-0.01
				26	1029.46	1029.42	0.04
				27	1028.47	1028.44	0.03
				28	1027.36	1027.39	-0.03
				29	1026.00	1026.05	-0.05
				30	1024.36	1024.55	-0.19
				31	1022.81	1023.15	-0.34

In cross section control made according to “Production Regulations of Big Scaled Map and Map Information” on agenda of Turkey; 90% of difference of heights, found as a result of both measure methods should not be more than 1/3 of contour line interval, and 10% of this difference should not be more than 1/2 of contour line interval. Contour line interval assigns 1 m. When Table 1 was seen, differences in West-East and North-South cross sections remained in side of limits determined.

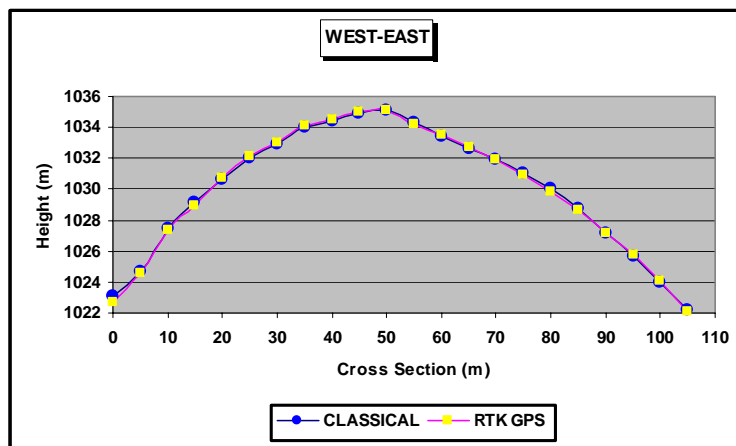


Figure 4. Changes on heights in West-East cross section

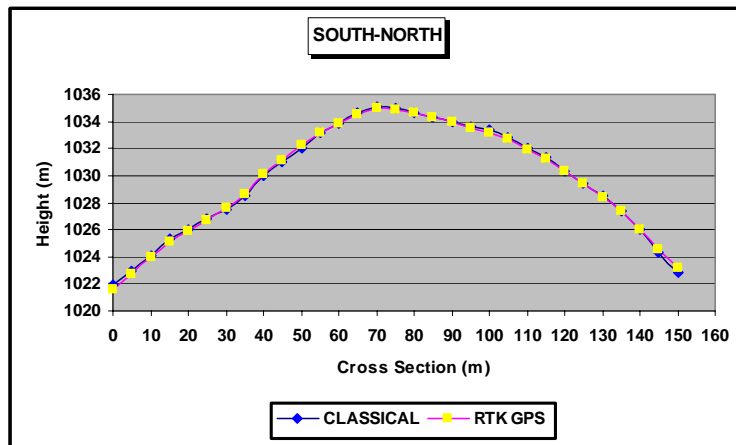


Figure 5. Changes on heights in South-North cross section

6. CONCLUSION




In this study, data in RTK GPS were close to classical measurements. This assign that necessary data to create DTM could be obtained from RTK GPS. Advantage of RTK GPS than classical measurements in obtaining height data is that facing rover station to base station is unnecessary. But this situation is limited with radio broadcasting used in RTK GPS. To solve this problem base station should be founded in higher point be should be far from anti signal effects. In this situation, multi points could be selected as base station. The other advantage of RTK GPS is lower number of necessary persons than that of classical methods. This makes big save in economy and labour.

Table 1 shows that difference between heights in West-East and South-North cross sections were ± 0.39 m and ± 0.34 m respectively. Differences in places close to starting and ending points of cross sections were bigger than data in Table 1. To solve this problem it is necessary that points used to create DTM in interpolation technique should be exceeded from study area, and especially suitable geoid models should be selected in big study area. Under these conditions, data, used to create DTM in big area could be obtained safety, fast from RTK GPS.

7. REFERENCES

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