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Comparative Analysis of GNSS (RTK) and Total Station-Derived Results in Topographical Mapping

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Abstract

The research is on the comparative analysis of GNSS (RTK) and Total Station derived results in the topographic mapping of Campus 3, of Auchi Polytechnic Auchi. The aim is to compare the results obtained using Global Navigational Satellite Systems (Real Time Kinematics) and Total Station Instrument (Co-ordinates mode). The two instruments were used to obtain survey data from the same location, and their topographic plans were produced and compared. A real-time survey was carried out with the Hi-Target GNSS receiver using the slave connected to the CORS Station, which was the base of the GNSS receiver. The slave was used to pick coordinates at all stations around the perimeter and consequently used to survey all the details in the study area. The data obtained by the Hi-Target GNSS receiver was transferred into the computer system via Bluetooth; while the Total Station was used to obtain the coordinates in coordinate mode. The adjusted coordinates and the detailed survey of both the Hi-Target GNSS receiver and the Total Station were plotted using AUTOCAD 2014. The contour lines were created by the use of Surfer 7 software using the data from the two instruments. The results of both methods were compared to get the variations produced by the two methods. The accuracy of the GNSS (RTK) was 1:31000 and that of the Total Station accuracy was 1:29000. It was concluded that the two methods yielded good results in terms of position accuracy with mean differences of 12mm, 13mm and 8mm in Eastings, northings and elevation respectively. It was recommended that either of the methods can be used for topographic surveying however, based on the values of their linear accuracy it can be inferred that, the accuracy obtainable from the data obtained using the GNSS (Hi-Target) instrument is better than that of Total Station instrument. Generally, the two instruments and their methods of data acquisition and processing are within the standard and scope of topographical mapping, therefore they are both suitable for topographical surveying.

Keywords: GNSS (RTK), Total Station, CORS Station, Topographical Mapping

1. Introduction

Topographical mapping is a vital aspect of geospatial science, providing accurate and detailed representations of the earth's surface. The increasing demand for precise and reliable topographical data has led to the development and adoption of various surveying technologies. Two prominent technologies used in topographical mapping are Global Navigational Satellite System (GNSS) Real-Time Kinematic (RTK) and Total Station. While both methods have their strengths and limitations, a comprehensive comparative analysis of their derived results is essential to determine their accuracy, reliability, and suitability for topographical mapping applications. Topographical mapping is all-encompassing and involves the determination of horizontal and vertical positions.

Chekole (2014) [6] analysed the accuracy, precision, and time required for Total Station and GPS measurements. For this analysis, a reference network with 14 control points was measured five times using the Leica 1201 Total Station, which provided a reference for comparison with RTK measurements. The points measured with the Total Station achieved a precision of 1mm for both horizontal and vertical coordinates. The results showed that when employing the RTK method on the same reference network points, an accuracy of 9mm in horizontal and 1.5cm in vertical coordinates was obtained. The five sets of RTK measurements had a maximum standard deviation of 8mm for horizontal and 1.5cm for vertical coordinates.

Diwakar *et al.*, (2014) [7] researched to compare the horizontal precision of Differential-GPS (DGPS) and Total Station tools. The investigation focused on how the duration of observations influences the accuracy achieved. To accomplish this, 19 points were set up, and readings were taken using both Total Station (TRIMBLE M3) and DGPS (TRIMBLE R3). The distances determined from DGPS data for consecutive points were compared with those computed using the Total Station. The mean error, root mean square error (RMSE), and standard deviation of the distances calculated from DGPS were derived from the Total Station measurements. The standard deviation and standard error for the 25-minute observation were calculated to be 0.013 meters and 0.003 meters, respectively. The accuracy of the DGPS survey relies on the duration of observation, and the research established that extended observation times yield improved accuracy.

The GNSS-RTK (Global Positioning System - Real Time Kinematic) system is regarded as the most effective technology for topographic surveys among satellite survey options. Obstacles can restrict the simultaneous communication between the reference receiver and the mobile receiver, as well as disrupt the necessary communication among the five satellites needed for GPS reliability to reach 100% (Malarski, *et al*., 2009) [12]. Surveys conducted using GPS-RTK are not only efficient and rapid but also provide more precise topographic maps for design purposes, especially in open areas free from obstacles, and when a model is used to create contours (Kizil and Tisor, 2011) [9].

In numerous construction and property monitoring procedures, data is gathered using a Total Station (TS). Additionally, TS is a more effective technique for performing topographic surveys compared to utilizing a Theodolite for private firms in Indonesia, regardless of whether it is carried out by the owner, contractor, or consultant. This device not only delivers high precision but also facilitates automatic data computation. Observations from a Total Station achieve a standard deviation of just 1 mm (Shetye, 2011 [13]; Chekole, 2014 [6]). These positions are important in many applications such as construction works especially vertical positions (Lin, 2004 [11]; Kutalmis, et al, 2017; Alizadeh-Khameneh, et al, 2018 [3]; Weaver, et al, 2018 [14]).

To evaluate the compatibility between the GNSS (RTK) technique and the Total Station method, Ahmed (2000) [1] conducted tests comparing measurements from both systems on a pre-existing network. The findings indicated that the discrepancy between the coordinates obtained from the total station and those from the GPS RTK was 2cm for horizontal coordinates and 3cm for vertical coordinates. According to Featherstone and Stewart (2001) [8], a test network comprising 60 points was established at Curtin University of Technology's Bentley Campus in Perth, Western Australia. No indications of vertical bias were found in the test network, and the estimated error of 15 mm (at 95% confidence) for the control WGS84 ellipsoidal heights seems to be plausible.

Ceylan *et al.*, (2005) [4] conducted experiments to evaluate the height accuracy achieved by various methods: geometric leveling utilizing an automatic level with a wooden rod, digital leveling with a barcoded rod, trigonometric leveling using a theodolite, a total station, and GPS. The root mean square errors for these methods were as follows: ±3.7mm, ±2.0mm, ±16.4mm, ±14.7mm, and ±18.8mm, respectively. The results indicate that the height accuracy of the total station is superior to that of the GPS by 25%.

2. Statement of the Problem

The advent of modern instruments in surveying has revolutionised the profession in that survey operations are carried out faster and more accurate results and products are obtained. Every sphere of development on the earth's surface requires a topographic map in solving geospatial problems. Analogue methods were used in the past in producing topographic maps, which limited the accuracy of the outputs. Details and surveyed point positions are not inaccurate or exact positions. The old method involves rigorous and tedious methods of data processing through computations. Also. It takes more time for maps to be produced. Instruments like theodolite, Level, chain, tapes, and compass were used thereby creating a cumbersome process. The storage approach of hard copy maps exposes them to destruction and loss, making development and spatial planning highly challenging. These have underscored the inability of the polytechnic authority to secure various maps such as topographical maps that are useful in setting out structures, facilities and other locations and campuses.

3. Aim and Objectives

This research aims to compare the accuracy of GNSS (RTK) and Total Station derived results in the topographic mapping of Campus 3, of Auchi Polytechnic Auchi. These would be accomplished through the following objectives:

1. Office and field reconnaissance of the study area.
2. Observation of spatial location of both natural and man-made features within the study area using GNSS (RTK) and Total Station
3. Processing of field observations to produce topographic maps.
4. Make recommendations based on the results obtained

4. Study Area

The study area is Campus 3 Auchi Polytechnic Auchi; Etsako West Local Government Area Edo State. Auchi Polytechnic Campus 3 is situated within a defined geographical boundary comprising various academic, and administrative blocks. The study area includes all buildings within the campus ranging from lecture halls to administrative offices. It lies between latitude 6^0 56' 27.5" N to 6^0 54' 8.316" N of the equator and longitude 5^0 59' 4.49" E to 5^0 55' 52.212" E of the Greenwich Meridian. It is located in the northern part of Edo State.

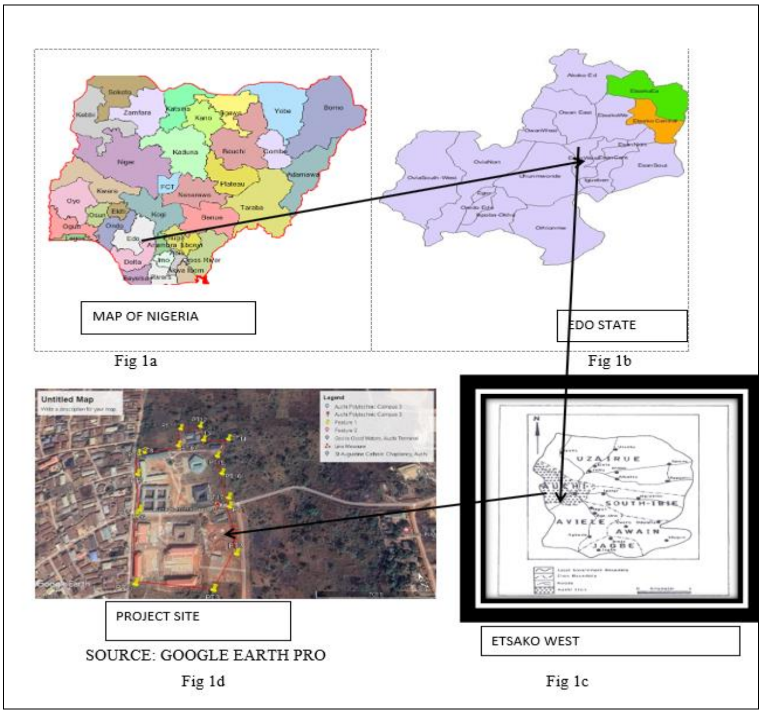


Fig 1

5. Methodology

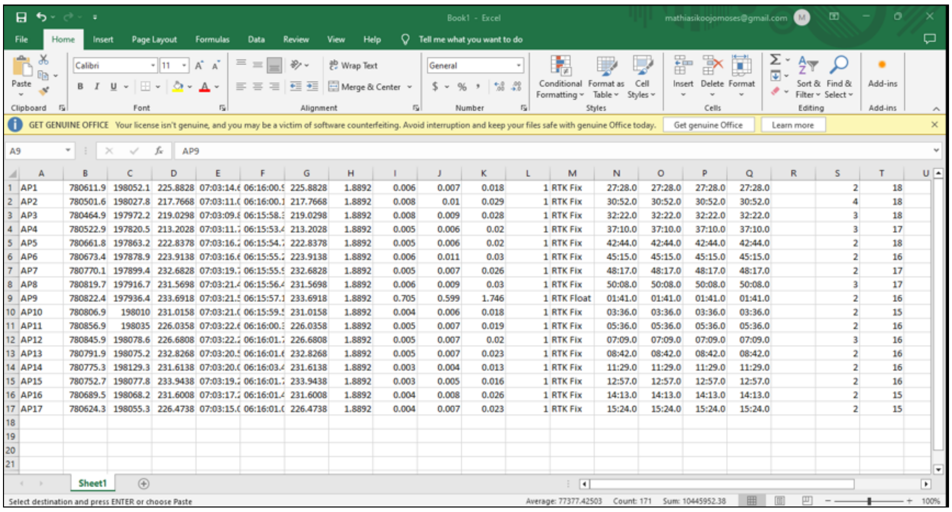
The research goal is to compare the derived results of Topographic Mapping of Campus 3 of Auchi Polytechnic Auchi using GNSS (RTK) receiver and Total Station instrument. To achieve this, office reconnaissance and field reconnaissance of the study area was carried out, field observation was embarked upon to obtain the spatial location of both natural and artificial features within the project area using Total Station and GNSS Instrument, the field data were processed and two topographic maps of the study area were produced using the two different survey instruments and finally recommendations were made based on the acquired results. The instrument model used were the Hi-Target Differential Global Positioning System Rover and its accessories (V90; Serial No. VAPG11644048) and Leica Total Station (TS06 PLUS)

Different survey methods and techniques are involved in the execution of this project. Such methods include the reconnaissance survey, data acquisition, and data processing. All these methods were made possible with the use of GNSS Receiver and Total Station for observing the boundary points and picking the coordinates of the spot height and details within the boundary. The following software was used in the execution of the research Google Earth Pro 7.3.2, Microsoft Office 2011, AutoCAD Land Dev. 2017, and Surfer 10.

The GNSS was operated in real-time kinematic (RTK) mode while the total station was used in coordinate mode. The horizontal angle was deduced and the collimation and index error test were computed as 02" and 01" respectively.

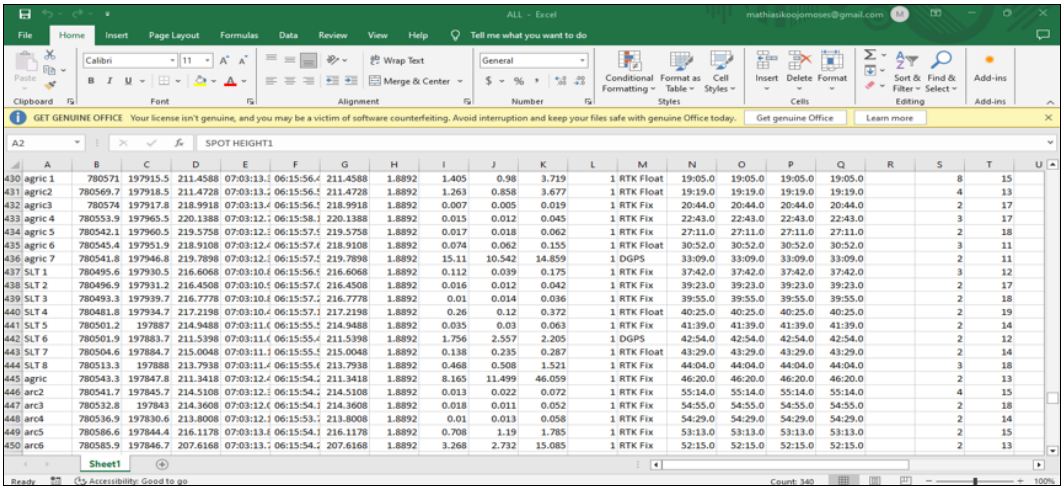
In-situ check was done before the fieldwork began and it was done using three of the control points which are DSG002, DSG003 and DSG004 the distance and bearing between the three control points were computed and with the coordinate of DSG002 (780614.512mN,198210.412mE), DSG003 (780605.516mN, 198105.230mE) and DSG004 (780517.154mN, 198055.944mE) the distance and bearing were computed. 03" and 0.005m were the difference in the angle and distance respectively.

5.1 Observed Coordinate of Points and Spot Heights Obtained Using GNSS (RTK)



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	AP1	780611.9	198052.1	225.8828	07:03:14.6	06:16:00.9	225.8828	1.8892	0.006	0.007	0.018	1	RTK Fix	27:28.0	27:28.0	27:28.0	27:28.0		2	18
2	AP2	780501.6	198027.8	217.7668	07:03:11.0	06:16:00.1	217.7668	1.8892	0.008	0.01	0.029	1	RTK Fix	30:52.0	30:52.0	30:52.0	30:52.0		4	18
3	AP3	780464.9	197972.2	219.0298	07:03:09.8	06:15:58.3	219.0298	1.8892	0.008	0.009	0.028	1	RTK Fix	32:22.0	32:22.0	32:22.0	32:22.0		3	18
4	AP4	780522.9	197820.5	213.2028	07:03:11.7	06:15:53.4	213.2028	1.8892	0.005	0.006	0.02	1	RTK Fix	37:10.0	37:10.0	37:10.0	37:10.0		3	17
5	AP5	780661.8	197863.2	222.8378	07:03:16.2	06:15:54.7	222.8378	1.8892	0.005	0.006	0.02	1	RTK Fix	42:44.0	42:44.0	42:44.0	42:44.0		2	18
6	AP6	780673.4	197878.9	223.9138	07:03:16.6	06:15:55.2	223.9138	1.8892	0.006	0.011	0.03	1	RTK Fix	45:15.0	45:15.0	45:15.0	45:15.0		2	16
7	AP7	780770.1	197899.4	232.6828	07:03:19.7	06:15:55.9	232.6828	1.8892	0.005	0.007	0.026	1	RTK Fix	48:17.0	48:17.0	48:17.0	48:17.0		2	17
8	AP8	780819.7	197916.7	231.5698	07:03:21.4	06:15:56.4	231.5698	1.8892	0.006	0.009	0.03	1	RTK Fix	50:08.0	50:08.0	50:08.0	50:08.0		3	17
9	AP9	780822.4	197936.4	233.6918	07:03:21.5	06:15:57.1	233.6918	1.8892	0.705	0.599	1.746	1	RTK Float	01:41.0	01:41.0	01:41.0	01:41.0		2	16
10	AP10	780806.9	198010	231.0158	07:03:21.0	06:15:59.5	231.0158	1.8892	0.004	0.006	0.018	1	RTK Fix	03:36.0	03:36.0	03:36.0	03:36.0		2	15
11	AP11	780856.9	198035	226.0358	07:03:22.6	06:16:00.3	226.0358	1.8892	0.005	0.007	0.019	1	RTK Fix	05:36.0	05:36.0	05:36.0	05:36.0		2	16
12	AP12	780845.9	198078.6	226.6808	07:03:22.2	06:16:01.7	226.6808	1.8892	0.005	0.007	0.02	1	RTK Fix	07:09.0	07:09.0	07:09.0	07:09.0		3	16
13	AP13	780791.9	198075.2	232.8268	07:03:20.5	06:16:01.6	232.8268	1.8892	0.005	0.007	0.023	1	RTK Fix	08:42.0	08:42.0	08:42.0	08:42.0		2	16
14	AP14	780775.3	198129.3	231.6138	07:03:20.0	06:16:03.4	231.6138	1.8892	0.003	0.004	0.013	1	RTK Fix	11:29.0	11:29.0	11:29.0	11:29.0		2	16
15	AP15	780752.7	198077.8	233.9438	07:03:19.2	06:16:01.7	233.9438	1.8892	0.003	0.005	0.016	1	RTK Fix	12:57.0	12:57.0	12:57.0	12:57.0		2	16
16	AP16	780689.5	198068.2	231.6008	07:03:17.2	06:16:01.4	231.6008	1.8892	0.004	0.008	0.026	1	RTK Fix	14:13.0	14:13.0	14:13.0	14:13.0		2	15
17	AP17	780624.3	198055.3	226.4738	07:03:15.0	06:16:01.0	226.4738	1.8892	0.004	0.007	0.023	1	RTK Fix	15:24.0	15:24.0	15:24.0	15:24.0		2	15

5.2 Observed Coordinates of Details Obtained Using GNSS (RTK)



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
430	agric 1	780571	197915.5	211.4588	07:03:13.	06:15:56.	211.4588	1.8892	1.405	0.98	3.719	1	RTK Float	19:05.0	19:05.0	19:05.0	19:05.0		8	15
431	agric2	780569.7	197918.5	211.4728	07:03:13.	06:15:56.	211.4728	1.8892	1.263	0.858	3.677	1	RTK Float	19:19.0	19:19.0	19:19.0	19:19.0		4	13
432	agric3	780574	197917.8	218.9918	07:03:13.	06:15:56.	218.9918	1.8892	0.007	0.005	0.019	1	RTK Fix	20:44.0	20:44.0	20:44.0	20:44.0		2	17
433	agric 4	780553.9	197965.5	220.1388	07:03:12.	06:15:58.1	220.1388	1.8892	0.015	0.012	0.045	1	RTK Fix	22:43.0	22:43.0	22:43.0	22:43.0		3	17
434	agric 5	780542.1	197960.5	219.5758	07:03:12.	06:15:57.	219.5758	1.8892	0.017	0.018	0.062	1	RTK Fix	27:11.0	27:11.0	27:11.0	27:11.0		2	18
435	agric 6	780545.4	197951.9	218.9108	07:03:12.	06:15:57.	218.9108	1.8892	0.074	0.062	0.155	1	RTK Float	30:52.0	30:52.0	30:52.0	30:52.0		3	11
436	agric 7	780541.8	197946.8	219.7898	07:03:12.	06:15:57.	219.7898	1.8892	15.11	10.542	14.859	1	DGPS	33:09.0	33:09.0	33:09.0	33:09.0		2	11
437	SLT 1	780495.6	197930.5	216.6068	07:03:10.	06:15:56.	216.6068	1.8892	0.112	0.039	0.175	1	RTK Fix	37:42.0	37:42.0	37:42.0	37:42.0		3	12
438	SLT 2	780496.9	197931.2	216.4508	07:03:10.	06:15:57.	216.4508	1.8892	0.016	0.012	0.042	1	RTK Fix	39:23.0	39:23.0	39:23.0	39:23.0		2	17
439	SLT 3	780493.3	197939.7	216.7778	07:03:10.	06:15:57.	216.7778	1.8892	0.01	0.014	0.036	1	RTK Fix	39:55.0	39:55.0	39:55.0	39:55.0		2	18
440	SLT 4	780481.8	197934.7	217.2198	07:03:10.	06:15:57.1	217.2198	1.8892	0.26	0.12	0.372	1	RTK Float	40:25.0	40:25.0	40:25.0	40:25.0		2	19
441	SLT 5	780501.2	197887	214.9488	07:03:11.	06:15:55.	214.9488	1.8892	0.035	0.03	0.063	1	RTK Fix	41:39.0	41:39.0	41:39.0	41:39.0		2	14
442	SLT 6	780501.9	197883.7	211.5398	07:03:11.	06:15:55.	211.5398	1.8892	1.756	2.557	2.205	1	DGPS	42:54.0	42:54.0	42:54.0	42:54.0		2	12
443	SLT 7	780504.6	197884.7	215.0048	07:03:11.1	06:15:55.	215.0048	1.8892	0.138	0.235	0.287	1	RTK Float	43:29.0	43:29.0	43:29.0	43:29.0		2	14
444	SLT 8	780513.3	197888	213.7938	07:03:11.	06:15:55.	213.7938	1.8892	0.468	0.508	1.521	1	RTK Fix	44:04.0	44:04.0	44:04.0	44:04.0		3	18
445	agric	780543.3	197847.8	211.3418	07:03:12.	06:15:54.	211.3418	1.8892	8.165	11.499	46.059	1	RTK Fix	46:20.0	46:20.0	46:20.0	46:20.0		2	13
446	arc2	780541.7	197845.7	214.5108	07:03:12.	06:15:54.	214.5108	1.8892	0.013	0.022	0.072	1	RTK Fix	55:14.0	55:14.0	55:14.0	55:14.0		4	15
447	arc3	780532.8	197843	214.3608	07:03:12.	06:15:54.1	214.3608	1.8892	0.018	0.011	0.052	1	RTK Fix	54:55.0	54:55.0	54:55.0	54:55.0		2	18
448	arc4	780536.9	197830.6	213.8008	07:03:12.1	06:15:53.	213.8008	1.8892	0.01	0.013	0.058	1	RTK Fix	54:29.0	54:29.0	54:29.0	54:29.0		2	14
449	arc5	780586.6	197844.4	216.1178	07:03:13.	06:15:54.1	216.1178	1.8892	0.708	1.19	1.785	1	RTK Fix	53:13.0	53:13.0	53:13.0	53:13.0		2	15
450	arc6	780585.9	197846.7	207.6168	07:03:13.	06:15:54.	207.6168	1.8892	3.268	2.732	15.085	1	RTK Fix	52:15.0	52:15.0	52:15.0	52:15.0		2	13

Linear Accuracy for GNSS (RTK)

$$\text{Accuracy} = \frac{1}{\dfrac{\sqrt{\Sigma\Delta N^2 + \Sigma\Delta E^2}}{\Sigma D}}$$

$\Sigma\Delta N = -0.035$

$\Sigma\Delta E = -0.045$

Total distance = 1156.266

Accuracy = 1:31000

1/ 31000

5.3 Geometric Data Acquisition Using Total Station

The Total Station (Lece TS06 PLUS) instrument was set up on one of the control stations and necessary adjustments which are centring, level and focusing were performed. A new job was created. Click on program to set up our station. A page popped out showing station Id, HI (height of instrument) and coordinate. The necessary parameters were imputed for the station orientation.

The coordinates of the boundary points were obtained during the perimeter survey. Spot heightening and detailing of the study area were also embarked upon in coordinate mode.

Table 1: Observed Coordinate of Boundary Points of Total Station

Station	Northing (m)	Easting (m)	Height(m)
AP1	780606.558	198050.921	225.877
AP2	780501.613	198027.860	217.762
AP3	780464.859	197972.159	219.021
AP4	780522.914	197820.462	213.197
AP5	780661.832	197863.245	222.834
AP6	780673.384	197878.894	223.910
AP7	780770.047	197899.379	232.678
AP8	780819.672	197916.681	231.560
AP9	780822.388	197936.383	233.687
AP10	780806.876	198010.003	231.010
AP11	780856.856	198034.937	226.029
AP12	780845.841	198078.598	226.674
AP13	780791.85	198075.160	232.820
AP14	780775.242	198129.228	231.607
AP15	780752.664	198077.795	233.938
AP16	780689.468	198068.193	231.595
AP17	780613.799	198052.439	226.469

Linear Accuracy For Total Station

$$\text{Accuracy} = \frac{1}{\dfrac{\sqrt{\Sigma\Delta N^2 + \Sigma\Delta E^2}}{\Sigma D}}$$

$\Sigma\Delta N = -0.038$

$\Sigma\Delta E = -0.042$

Total distance = 1156.184

Accuracy = 1:29000

5.4 Plan Shewing Superimposed Topographic Map of Both the Total Station and GNSS

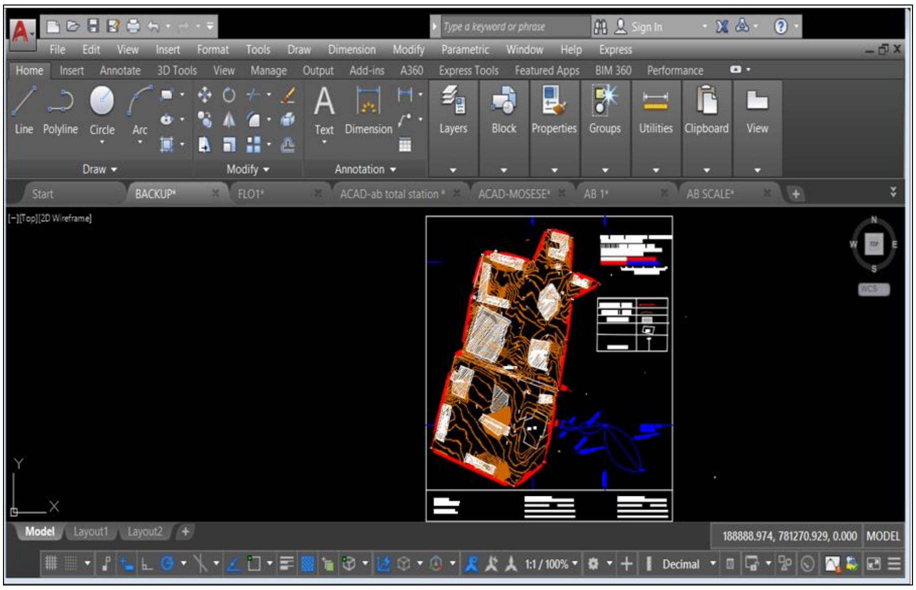


Fig 2: Superimposed Topographic Map of both the Total Station and GNSS

After both plans were superimposed a little shift was observed in the boundary points such as AP4 AP8, AP10, AP13, and AP14 but the shift was minimal.

5.5 Comparison Between the Coordinates of Boundary Points Obtained Using GNSS (RTK) and Total Station

Table 2: Showing the comparison between the coordinates of boundary points obtained using GNSS (RTK) and Total Station

S. No	Northing GNSS(Ym)	Northings Total Station(Ym)	Easting GNSS(Xm)	Easting Total Station(Xm)	Diff in northing(Ym)	Diff in easting(Xm)	Linear misclosure
AP1	780606.563	780606.558	198050.928	198050.921	0.005	0.007	0.009
AP2	780501.617	780501.613	198027.782	198027.776	0.004	0.006	0.007
AP3	780464.861	780464.859	197972.153	197972.159	0.002	0.006	0.006
AP4	780522.917	780522.914	197820.457	197820.462	0.003	0.005	0.006
AP5	780661.844	780661.832	197863.244	197863.245	0.012	0.001	0.0012
AP6	780673.391	780673.384	197878.900	197878.894	0.007	0.006	0.009
AP7	780770.075	780770.047	197899.395	197899.379	0.006	0.016	0.0017
AP8	780819.700	780819.672	197916.695	197916.681	0.028	0.014	0.0031
AP9	780822.421	780822.388	197936.406	197936.383	0.033	0.023	0.0040
AP10	780806.901	780806.876	198010.023	198010.003	0.025	0.020	0.0032
AP11	780856.881	780856.856	198034.956	198034.937	0.024	0.019	0.0031
AP12	780845.865	780845.841	198078.620	198078.598	0.024	0.022	0.0033
AP13	780791.867	780791.85	198075.180	198075.160	0.017	0.020	0.026
AP14	780775.254	780775.242	198129.251	198129.228	0.012	0.023	0.0026
AP15	780752.676	780752.664	198077.796	198077.795	0.012	0.001	0.012
AP16	780689.474	780689.468	198068.205	198068.193	0.006	0.012	0.013
AP17	780613.807	780613.799	198052.443	198052.439	0.008	0.006	0.01

The table above shows that the difference in Northings between the observed boundary coordinates using the GNSS receiver and Total station is in the range of 0.3 with the highest value being 0.3 and the lowest being 0.005. The mean difference in northing is thereafter computed as 1.2 while for the Eastings the range is 0.2 with the highest value as 0.2 and the lowest as 0.001 while the mean difference in Eastings is thereafter computed to be 1.3.

5.6 Comparison Between Distance Obtained From GNSS (RTK) and Total Station

Station	Distance for GNSS	Distance for Total Station	Error
AP1-AP2	106.954	106.950	0.005
AP2-AP3	66.675	66.669	0.006
AP3-AP4	162.425	162.420	0.005
AP4-AP5	145.366	145.362	0.003
AP5-AP6	19.454	19.449	0.005
AP6-AP7	98.834	98.828	0.006
AP7-AP8	52.555	52.550	0.005
AP8-AP9	19.898	19.891	0.008
AP9-AP10	75.235	75.228	0.007
AP10-AP11	55.860	55.854	0.006
AP11-AP12	45.035	45.031	0.004
AP12-AP13	54.107	54.103	0.004
AP13-AP14	56.566	56.559	0.007
AP14-AP15	56.192	56.185	0.007
AP15-AP16	63.925	63.920	0.005
AP16- AP17	77.189	77.185	0.004

The table above shows that the difference in distance between the GNSS(RTK) and Total station is in the range of 0.008 with the highest value Range being between 0.003 to 0.008 and the lowest being 0.003 while the mean difference for the is thereafter computed as 0.05.

5.6 Difference in Elevation Obtained From GNSS (RTK) and Total Station

Table 3: Difference in elevation obtained from GNSS (RTK) and Total Station

STN	Height of GNSS(RTK)	Height of Total Station	Diff in Height
AP1	225.882	225.877	0.005
AP2	217.766	217.762	0.003
AP3	219.029	219.021	0.008
AP4	213.202	213.197	0.005
AP5	222.837	222.834	0.003
AP6	223.913	223.910	0.003
AP7	232.682	232.678	0.005
AP8	231.569	231.560	0.009
AP9	233.691	233.687	0.004
AP10	231.015	231.010	0.005
AP11	226.035	226.029	0.006
AP12	226.680	226.674	0.004
AP13	232.826	232.820	0.006
AP14	231.613	231.607	0.006
AP15	233.943	233.938	0.005
AP16	231.600	231.590	0.010
AP17	226.473	226.469	0.004
			∑0.136

$$\frac{\text{Mean diff in height}}{\text{Total number of stations}} = \frac{0.136}{17} = 0.008\text{m}$$

Converting m to mm = 0.008×1000 = 8mm

From the above table, it shows that the difference in Height between the boundary points using GNSS and Total station is in the range of 0.1 with the highest value being 0.1 and the lowest being 0.003 while the mean difference in height is thereafter computed as 8mm.

5.7 Comparison of Bearing Obtained From GNSS (RTK) and Total Station

Table 4: Comparison of bearing obtained from GNSS (RTK) and Total Station

STN	Bearings Obtained Using GNSS(RTK)	Bearings Obtained Using Total Station	Diff in Bearings
AP1	192^0 26’ 15’’	192^0 26’ 14’’	00^0 00’ 01
AP2	236^0 32’ 45’’	236^0 32’ 30’’	00^0 00’ 15’’
AP3	290^0 56’ 33’’	290^0 56’31’’	00^0 00’ 01’
AP4	17^0 07’ 04’’	17^0 07’ 03’’	00^0 00’ 01
AP5	53^0 35’ 22’’	53^0 35’’56’’	00^0 00’ 34’’
AP6	11^0 58’ 06’’	11^0 58’ 00’’	00^0 00’06’’
AP7	19^0 13’ 09’’	19^0 13’ 17’’	-00^0 00’ 08’’
AP8	82^0 08’ 25’’	82^0 09’ 04’’	-00^0 00’ 39’’
AP9	101^0 54’ 17’’	101^0 54’ 54’’	00^0 00’ 37
AP10	26^0 30’ 46’’	26^0 30’ 49’’	00^0 00’ 03’’
AP11	104^0 09’ 35’’	104^0 09’ 34’’	00^0 00’ 01’’
AP12	183^0 38’ 43’’	183^0 38’ 37’’	00^0 00’ 06’’
AP13	107^0 04’ 45’’	107^0 04’ 31’’	00^0 00’ 14’’
AP14	246^0 18’ 31’’	246^0 17’ 58’’	00^0 00’ 33’’
AP15	188^0 37’ 44’’	188^0 37’ 22’’	00^0 00’ 22’’
AP16	191^0 45’ 59’’	191^0 45’ 39’’	00^0 00’ 20’’

The table above shows that the difference in bearings between the GNSS (RTK) and Total station is in the range of 0.008 with the highest value being 00^0 00’ 37” and the lowest being -00^0 00’ 08” while the mean difference for the is thereafter computed as 00^0 00’ 08”.The value gotten is acceptable.

6. Summary, Conclusion and Recommendations

6.1 Summary

The result of the analysis shows that the coordinates obtained from the two methods were compared and was found that the result did not show any significant difference. The figures of the surveyed area were also plotted from the two boundary coordinates. The figures did not differ from each other by any significant measure. The data obtained using the two methods was used to produce a topographic plan and the plans were superimposed, the result shows that the two superimposed precisely without any significant difference. The two methods can be recommended under the same working conditions based on the accuracy obtained using the two instruments. The accuracy obtained using the data obtained from the GNSS receiver (1:31000) was higher than that of the accuracy obtained using the data obtained using the Total Station instrument (1:29000). Therefore GNSS receiver is preferred for topographic surveying.

GNSS (RTK) technology utilises a network of satellites and ground-based reference stations to provide real-time positioning with centimetre–level accuracy. This method offers high precision, speed, and flexibility, making it an attractive option for large-scale topographical mapping projects while Total Station on the other hand, is a ground-based surveying instrument that uses electronic distance measurement and angular measurement to determine the positions of points. Total Station is renowned for its high accuracy and reliability, particularly in small-to medium-scale mapping projects.

6.2 Conclusion

The GNSS receiver and Total Station instrument were used in carrying out a topographic survey in Campus 3 Auchi Polytechnic Auchi Edo State, for the production of a topographic map of the area. Both instruments used were found to produce reliable data under similar conditions for the production of topographic maps. The final adjusted boundary coordinates determined by the two instruments yield good results based on precision. The topographic maps produced by the data obtained from the two instruments were superimposed. The superimposed maps show no significant difference based on the position of details and the boundary stations. The most suitable instrument at a time is the readily available instrument.

6.3 Recommendations

Based on the comparative analysis of GNSS (RTK) receiver and Total Station derived results in topographical mapping, it is recommended that:

1. GNSS receiver (in RTK mode) should be used for large-scale topographical mapping projects.
2. Total Station should be used for small-to-medium scale topographical mapping projects.
3. There should be regular and routine calibration and maintenance of GNSS (RTK) and Total Station equipment to ensure the accuracy and precision of derived results.
4. There should be training and capacity-building programs provided to surveyors and mapping professionals to enhance their skills and knowledge in using GNSS (RTK) and Total Station technologies.

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