Journal of Young Scientist, Volume VI, 2018
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

COMPARATIVE TOPO-GEODETIC STUDIES OF SOME POINTS PLACED IN THE UASVM CLUJ-NAPOCA CAMPUS USING A TOTAL STATION AND GPS RECEIVERS

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Abstract

The present paper was intended to carry out a study on precision obtained by classical measurements and satellite measurements. In this regard, the total station LEICA TCR805 and the TRIMBLE R10 GPS receiver were used. The instrumental observations were made in a leveling network, which had as its known elements the coordinates of a point and orientation, located in the premises of the UASVM Cluj-Napoca. In the case of classical measurements, we did not have control elements on the polygonal route taken into study, but measurements and calculations on the same route at another date were performed to verify the positioning accuracy of the points. The positioning of the polygon route was also achieved by the Rompos-RTK method. By comparing the coordinates obtained by the two methods we obtained the maximum differences on X = -0.076 m, on Y = 0.029 m and the linear deviation mt = 0.117.

***Key words**: comparative study, GPS, leveling network, total station.*

INTRODUCTION

Global Navigation Satellite Systems (GNSS) are systems that allow high precision of positioning in a geocentric reference system at any point on or near the terrestrial surface using Earth's artificial satellites.

Absolute Differential Positioning (RTK) is a positioning technique that determines the position of a receiver, usually mobile, based on direct satellite observations and some (differential) real-time corrections from another fixed receiver, also called as reference receiver or base receiver. A modern version allows generation of these corrections based on a network of reference stations (receivers), such as ANCPI's ROMPOS service. The pseudodistances measured by the mobile receiver are corrected based on the differential corrections obtained from the base receiver, and then an absolute (spot) positioning occurs. These differential corrections improve positioning precision.

In Romania there are 74 permanent GNSS stations, disposed at an approximate distance of 70 kilometers (Figure 1).

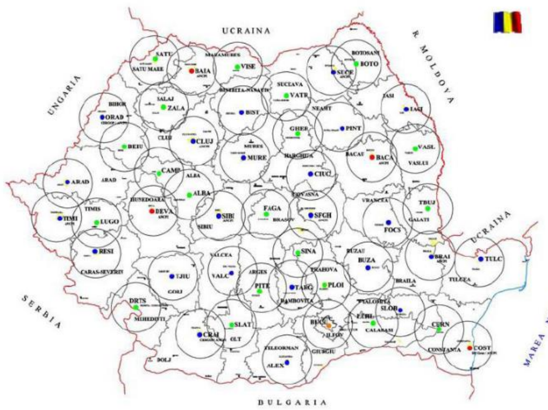

Figure 1. National Network of GNSS Stations

The objective of this paper is to compare the precisions obtained by classical measurements and satellite measurements. In this respect, was achieved in the UASVM Cluj-Napoca campus, a polygonal route supported on the coordinates of a point with far target.

MATERIALS AND METHODS

For the realization of the polygonal route, it was started from point 300 with a target to point 309. The coordinates of the starting points were previously determined from the triangulation network of Cluj-Napoca. On the polygon route shown in the Figure 2 were measured the azimuth directions and the distances on which the coordinates of the points were calculated. Since no control elements were available on the guideline and coordinates, as it was a floating polygonal track for point position control, the measurements and calculations were performed at another time.

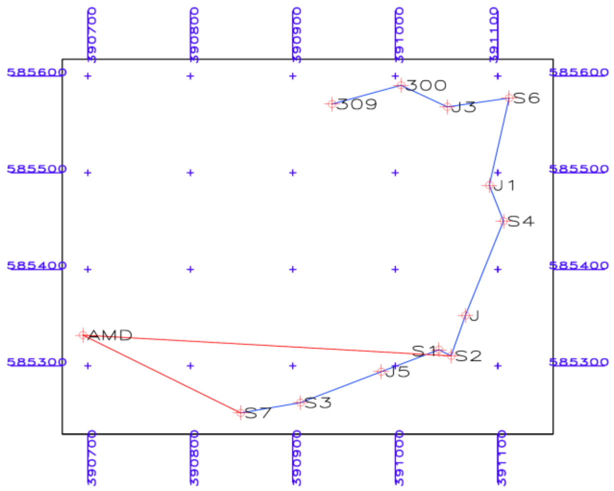

Figure 2. The polygonal route

The period analyzed in this study was 1990-2010.
For making the classical measurements was used a Leica TCR805 (Figure 3) total station and for the GPS measurements was used a Trimble R10 GPS receiver (Figure 4).
Leica TCR805 total station:
- is a total high precision station produced by one of the world leaders in topography measurement technology.
- is part of the new generation of topographic instruments, having in principle determined distances based on electromagnetic wave measurements.
- the advanced technology of the total station allows the collection, storage and transfer to a PC of azimuth directions, zenith directions and distances.
Being the smallest and easiest integrated receiver in its class, TrimbleR10 has an ergonomic design for operators to work as easily as possible.
Trimble HD-GNSS PROCESSING ENGINE: this amazing technology transcends traditional / uninitialized traditional techniques for a more accurate estimation of error estimates than currently provided by traditional GNSS technologies:

- Trimble Surepoint technology: provides shorter measurement times, high accuracy and more control over measurement quality.
- xFILL technology: With this technology, continuous measurements can be continued even when the ROMPOS network is lost.
- Trimble 360 - Receiver Technology: With Trimble 360, R10 receives signals from all existing GNSS constellations planned for the future.

Figure 4. Trimble R10 GNSS Receiver

The data, collected from Ministry of Agriculture and Rural Development, have been statistically processed and interpreted, building the trend line and setting up the forecast based on simulation models for the period 2012-2015.

RESULTS AND DISCUSSIONS

For the realization of the polygonal route, it was started from point 300 with a target to point 309 (Figure 5). The coordinates of the starting points were previously determined from the triangulation network of Cluj-Napoca. The coordinates of the points obtained using the total station are presented in Table 1.
To determine the GPS coordinates of the polygonal route points, the ROMPOS RTK method was used using RTCM0022-CLUJ station.
Note that GPS receivers determine geodetic coordinates based on pseudo-distances

determined by the constellation NAVSTAR and GLONASS.
The values obtained are presented in Table 2.

Table 1. Comparative coordinates obtained on the two measurements made

	23.03.2017	Total Station 1		27.03.2017	Total Station 2	
Point no.	x	y	z	x	y	z
309	585570,980	390938,250	356,180	585570,980	390938,250	356,180
300	585590,473	391005,560	356,850	585590,473	391005,560	356,850
J3	585568,131	391050,678	362,842	585568,145	391050,676	362,837
S6	585577,346	391111,011	369,389	585577,387	391111,010	369,391
J1	585486,974	391091,699	378,294	585487,014	391091,733	378,296
S4	585449,783	391105,500	382,275	585449,829	391105,553	382,273
J	585352,139	391068,311	392,622	585352,163	391068,418	392,621
S2	585310,390	391054,361	398,014	585310,402	391054,492	397,959
S1	585316,823	391042,552	394,837	585316,824	391042,681	394,779
J5	585293,971	390986,129	394,376	585293,924	390986,275	394,318
S3	585261,910	390907,388	390,602	585261,805	390907,561	390,524
S7	585251,296	390849,067	386,703	585251,148	390849,248	386,622

Table 2. Coordinates determined using the GNSS technology

	GPS coordinates		
Nr. Punct	x	y	z
309	585570,980	390938,250	356,180
300	585590,473	391005,560	356,850
J3	585568,083	391050,706	362,851
S6	585577,290	391111,020	369,400
J1	585486,957	391091,721	378,323
S4	585449,790	391105,520	382,300
J	585352,133	391068,364	392,667
S2	585310,390	391054,440	398,000
S1	585316,811	391042,619	394,804
J5	585293,966	390986,204	394,364
S3	585261,884	390907,492	390,570
S7	585251,280	390849,170	386,660

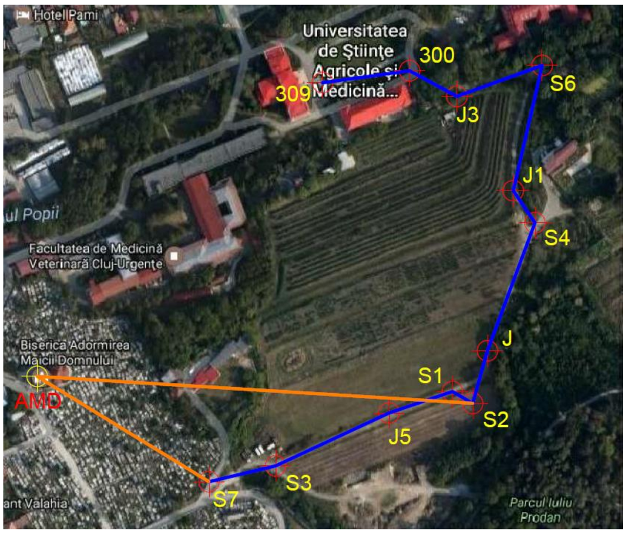

Figure 5. The polygonal route transposed on the map of the area of interest

In the graphs we can see the differences of the coordinates determined with GPS and classic technology with the total station. The largest difference on the x coordinate is at the S6 point of -7.6 cm, on the y coordinate at the J3 point of 2.9 cm, and on the level the highest difference is found at the J point of 4.6 cm.

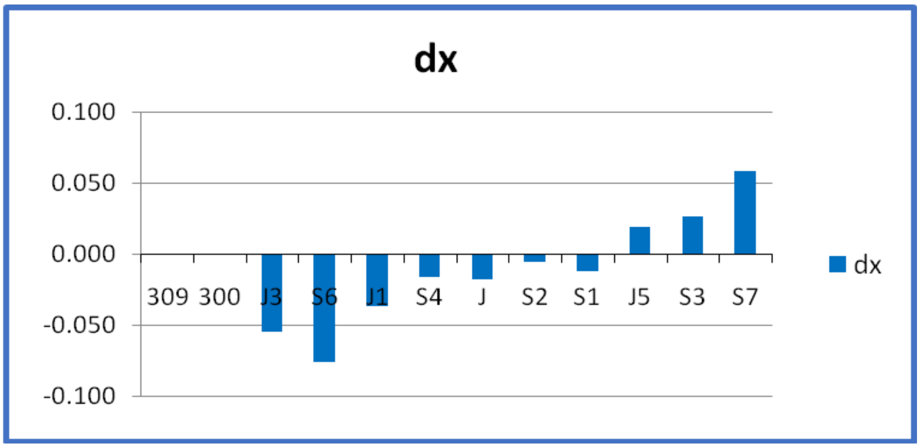

Figure 6. Differences on the X coordinates

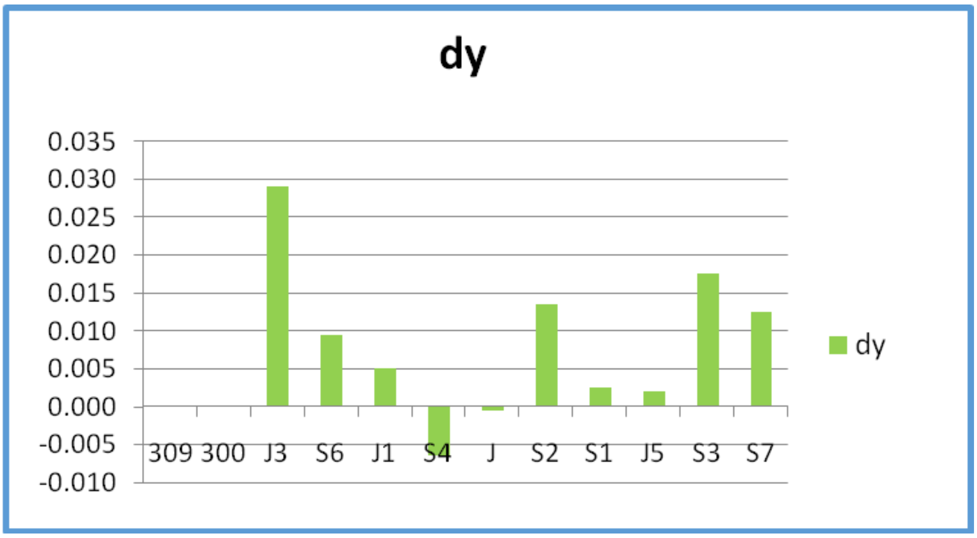

Figure7. Differences on the Y coordinates

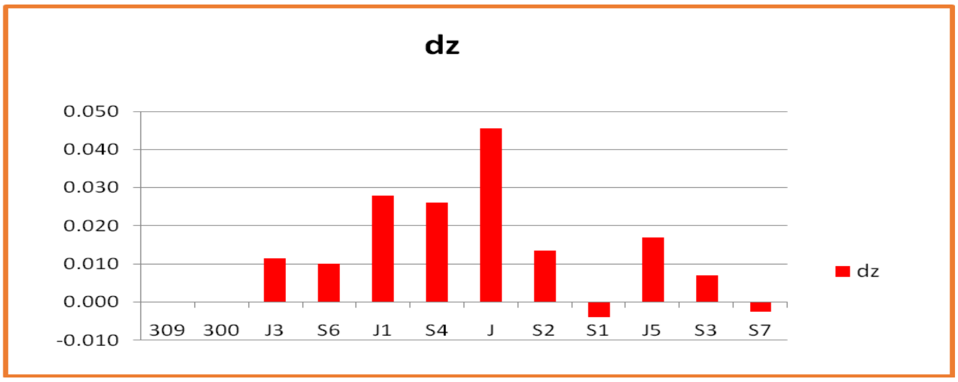

Figure 8. Differences on the Z coordinates

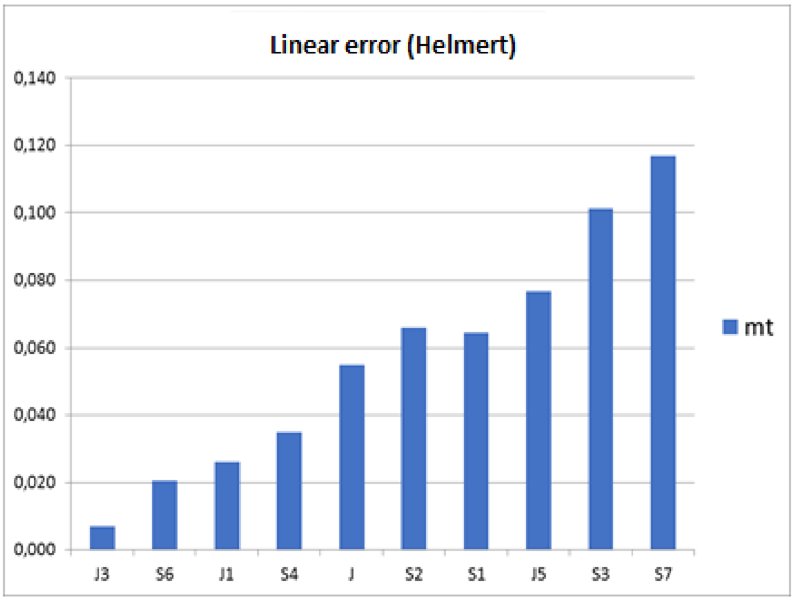

Figure 9. Linear error

It can be seen from the graph (Figure 9) that the linear error increases approximately proportionally to the distance from the starting point to the final point.

The work also compared the orientation from the last point of the polygon route to the AMD point, point on the "Adormirea Maicii Domnului" Church from Mănăştur. The difference between the calculated orientation from the S7 point obtained by the classical method and the AMD point coordinates is 9 minutes and 73 seconds. The difference between the calculated S7 point coordinates from GPS and AMD is 6 minutes and 79 seconds (Tables 3-5).

Table 3. Calculating the directions and distance from the last point of polygonation to a point in the triangulation network

Point	X	Y	D	□
s7	585251,148	390849,249		
AMD	585331,865	390695,169		
Δ	80,717	-154,080	173,941911	330,7205
s7(GPS)	585251,280	390849,170		
Δ	80,585	-154,001	173,8109612	330,6911

Table 4. Difference between the calculated coordinate and the calculated angle according to the angles measured

$d\theta_{7,AMD}=\theta^m-\theta^c=$	-0.0973^g	FLOAT

Table 5. Difference between the calculated orientation from the coordinates of the two triangulation points and the calculated orientation from the coordinates of the GPS point and the coordinates of a triangulation point

$d\theta_{7,AMD}=\theta^c-\theta^c=$	-0.0679^g	GPS-CLASSIC

CONCLUSIONS

From Figure 9 it is noted that the linear error of the points in the floating polygonal path increases in proportion to the distance from the starting point to the final point.

Between the coordinates of the points of the lifting network established by GPS technology and classical technology, there are significant differences. In this sense it is indicated that the starting and closing orientation is calculated from the coordinates of the points established with the same technology.

In view of the high accuracy achieved in the case of GPS elevations and the reduced period of time in making the lift route, it is advisable to always use GPS technology in the case of "clear sky".

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