TOPOGRAPHIC SURVEY OF THE SPORTS GROUNDS AND DORMITORIES OF THE BUASVM TIMISOARA, ROMANIA

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Abstract
This paper presents the topographic survey of an area within the campus of the Banat's "King Michael I of Romania" University of Agricultural Science and Veterinary Medicine of Timisoara, Romania, an area that covers the sports grounds and the dormitories. To do so, we used the concept of routing supported on both ends by coordinate points and known orientations that suppose a multiplication of the geodesic network to determine the coordinates of the detail points in the field. The multiplication of the geodesic network was done by determining the coordinates of some points of the order V that became the main elements of the topographic survey. This is why determining them should rely on a very accurate measurement. The topographic survey was done with special topographic instruments: an electronic instrument for the measurement of distances and a Leica TC805 total station. The total station is an optical instrument, a combination between a classical theodolite and an electronic device for the measurement of distances. The coordinates of the control points were determined with GPS equipment, which offers a quick control of static measurements. Data collected by the total station were downloaded with Leica GeoOffice Combined software and compensated through the TopoSys software. TopoSys calculates and compensates any combination of measurement of distances and angles to determine the best correction of the point coordinates. The coordinate processing method allows precision up to an order of centimetres. The coordinates of the compensated points were reported in the AutoCad with a TopoLT programme that operates on the AutoCad platform. This paper is important because presents a situation plan of the area described above in order to identify details; the plan will be used in future works for different goals within the university.

Key words*: *topographic survey, total station, GPS equipment, routing, Leica GeoOffice Combined, TopoSys, TopoLT

INTRODUCTION

Land measurements have always been used by people to represent land areas that meet economic needs, to organise building sites and route sites, to systematise localities, to organise military, mining, agricultural, forestry operations, etc. The development of the science of topographic survey and of topography in particular should be seen in close relationship with the appearance and improvement of topographic devices, thus increasing precision and yield of mapping.

Planar surveying of a land area is the ensemble of operations through which all the data necessary for a topographical survey are represented at the scale of the measured area.

The main mapping elements are represented by the topographic parameters angle, distance and level difference, with which we transpose to the topographic level a certain common or special item. To do so, we need to know the route and identify the station points, to establish the geometric elements with which to define the position in the space of the item and to determine the topographic elements used in the measurements sketch.

Mapping planar details designates the ensemble of measurements, calculus and plan representation of the field situation. Mapping planar details relies on a series of known points that make up the mapping support network. The planar support system should be represented at land level by a network of the order V made up of points marked in the field and by the coordinates of the system.

The planar surveying of an area is unitary, homogeneous, continuous and accurate only if we use the proper measurement methods relying on a properly established geometric network. To map details, we establish in the field a planar surveying basis that increases the support network.

The routing method is specific to topographic mapping networks; it is used mainly in the rendering of elongated details.

In planar routing, we measure angles and distances or orientations and distances. The main problem is to find the coordinates of a new point P(X,Y) through peeps exclusively for this new point P to three old points $A(X_A,Y_A)$, $B(X_B,Y_B)$ and $C(X_C,Y_C)$ through their coordinates. The solution to this problem was given by Snellius in 1624 and improved by Pothénot in 1692; it is also known as the "Pothénot Problem" or the Map Problem".

The topographic survey presented in this paper was done on an area within the campus of the Banat's "King Michael I of Romania" University of Agricultural Science and Veterinary Medicine of Timisoara, Romania, an area that covers the sports grounds and the dormitories. Determining the point coordinates was done with topographic instruments that we present below.

MATERIALS AND METHODS

The working methods used to carry out this project were the method of the routing supported at both ends on coordinate points and known orientations and the method of radiation with total station.

The routing is represented in the plan as a broken polygonal line in which the mutual position of the points is determined by measuring the distances between the breaking points and by measuring the angles in the breaking points of the polygonal route.

The routing supposes the increase of the geodesic network to determine the detail point coordinates in the field. The increase of the geodesic network was done by determining the coordinates of some points of the order V that become the main elements of the topographic survey. This is why measuring them supposes a very accurate measurement.

In the design of the routing, we took into account the choice of the routing depending on the alleys available in the area, and the establishment of the routing points so that they allow visibility between them and between them and the radiated points, and in safe areas that allow the apparatus to be mounted without problems.

The characteristic points of planar and level details are done through the radiation method, a method used in any point from which we can peep and measure a distance. The position in the plan of a radiated point (new) is defined depending on the points A and B (old) in the mapping network through the polar angle or orientation θ_{A1} and on the distance reduced to the horizon d_{A1}. In general, the radiated points are located around the station and they are peeped successively by going along the horizon line.

The topographic instruments we use are the Leica TC805 total station and the Leica GeoSystems GPS1205+ equipment.

The total station, through its structure and opportunities, has become the representative instrument used nowadays exclusively to measure routing; it is also the only serious competitor of GPS.

The total station is an optic instrument used in topographic survey. More precisely, it is a combination between the classical theodolite and an electronic instrument for the measurement of distances. We usually measure, with a total station, the vertical and horizontal angles depending on the real North, as well as distances to the measured point.

A total station is made up of a theodolite with a measurement apparatus with incorporated diatomite that can measure both angles and distances at the same time. Nowadays' electronic total stations all have an opto-electronic distance measuring apparatus (EDM) with electronic scanning of angles. Coded scales of horizontal and vertical circles are scanned electronically and then angles and distances are displayed digitally. Horizontal distance, height difference and coordinates are calculated automatically and all measurements and supplementary information can be recorded.

Leica total stations are equipped with a software package that allows that most topographic operations are done easily, quickly, and in an elegant way.

The GPS was used to determine the coordinates of the control points (the ends of the routing) of the topographic survey.

GPS technology uses signals transmitted by satellites whose trajectories are such that any point on the Earth's surface can be determined in 24 hours, no matter the meteorological conditions. The accuracy of the positioning depends on the type of GPS receiver and on the observation and post-processing techniques.

Compared to the use of total station, GPS technology offers the advantage that the points that are to be measured should not be visible mutually.

Leica GPS1205+ is made up of the colour controller Leica RX1200 and the Leica ATX1250 antenna, with the rover solution "all on the stick".

Data thus collected by the total station were downloaded with Leica GeoOffice Combined software and compensated through the TopoSys software. TopoSys calculates and compensates any combination of measurements of distances and angles to determine the best correction of the measured point coordinates. The coordinate processing method allows accuracy up to the order of centimetres. With this software, we can create a DXF file that can be later uploaded into the AutoCAD.

RESULTS AND DISCUSSION

The topographic survey was done on both sides of the sports grounds and dormitories within the campus of the Banat's "King Michael I of Romania" University of Agricultural Science and Veterinary Medicine of Timisoara, Romania.

The control points along the routing, i.e. the station points S1, S2, S3, S9, and S11 were mapped with the GPS. The other station points, S4, S5, S6, and S7, were calculated after the routing with the total station.

The starting point of the routing is represented by the station point S1 in the ecological park of the Faculty of Agriculture marked in the field by a metal bolt. Orientation was done from the coordinates on the station point S2 that was later read. From the station point S1 we peeped ahead of us and read the station point S3, and so on until the end of the routing.

The routing was closed on the station points S9 and S11 read from the station point S8. The station point S10 was mapped with GPS but, because of the multi-path effect, it recorded a quota difference of about 1 m and was no longer taken into account as a station point in the calculus of the routing.

The coordinates of the points belonging to the routing determined in the field, their compensated values and the resulting corrections are shown in the tables below.

Table 1

Coordinates of the station points determined GPS in the routing – STEREO 1970

Station point	Materialisation	Coordinates of the station points in the field		
		X [m]	Y [m]	Z [m]
S1	Metal bolt	482733.713	206119.057	90.136
S2	Metal bolt	482721.883	206152.793	89.997
S3	Metal bolt	482709.463	205995.275	90.122
S8	Metal bolt	482793.812	205954.216	90.356
S9	Metal bolt	482795.362	206000.724	90.304
S11	Metal bolt	482779.642	206053.909	90.323

Table 2

Coordinates of the station points determined in the field in the routing – STEREO 1970

Station point	Materialisation	Coordinates of the station points in the field		
		X [m]	Y [m]	Z [m]
S4	Wooden pale	482719.678	205964.458	89.826
S5	Metal bolt	482704.455	205927.768	89.216
S6	Metal bolt	482747.894	205922.715	89.330
S7	Metal bolt	482792.610	205916.915	89.407

Table 3

Coordinates of the station points compensated in the routing – STEREO 1970

Station point	Materialisation	Coordinates of the station points in the field		
		X [m]	Y [m]	Z [m]
S1	Metal bolt	482733.713	206119.057	90.136
S2	Metal bolt	482721.883	206152.793	89.997
S3	Metal bolt	482709.463	205995.275	90.122
S4	Wooden pale	482719.671	205964.478	89.826
S5	Metal bolt	482704.518	205927.759	89.216
S6	Metal bolt	482747.876	205922.715	89.330
S7	Metal bolt	482792.563	205916.894	89.407
S8	Metal bolt	482793.812	205954.216	90.356
S9	Metal bolt	482795.362	206000.724	90.304
S11	Metal bolt	482779.642	206053.909	90.323

Table 4

Corrections of the coordinates of the station points in the routing – STEREO 1970

Station point	Materialisation	Corrections	
		X [cm]	Y [cm]
S4	Wooden pale	5.556	3.350
S5	Metal bolt	1.835	2.793
S6	Metal bolt	0.039	0.575
S7	Metal bolt	-2.854	-1.657

After field topographic measurements, we processed the data and designed the plan. Figure 1 shows the routing shape and the calculus of the network in TopoSys.

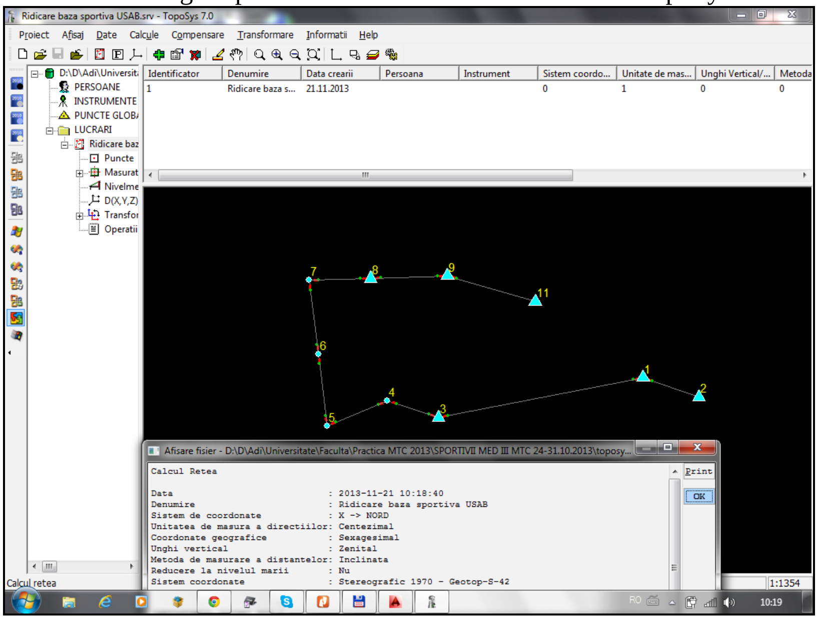

Figure 1. Calculus of the network in TopoSys

For each station point of the routing we reported the radiated points as shown in Figure 2 for the station point S1 and in Figure 3 for all the station points of the routing.

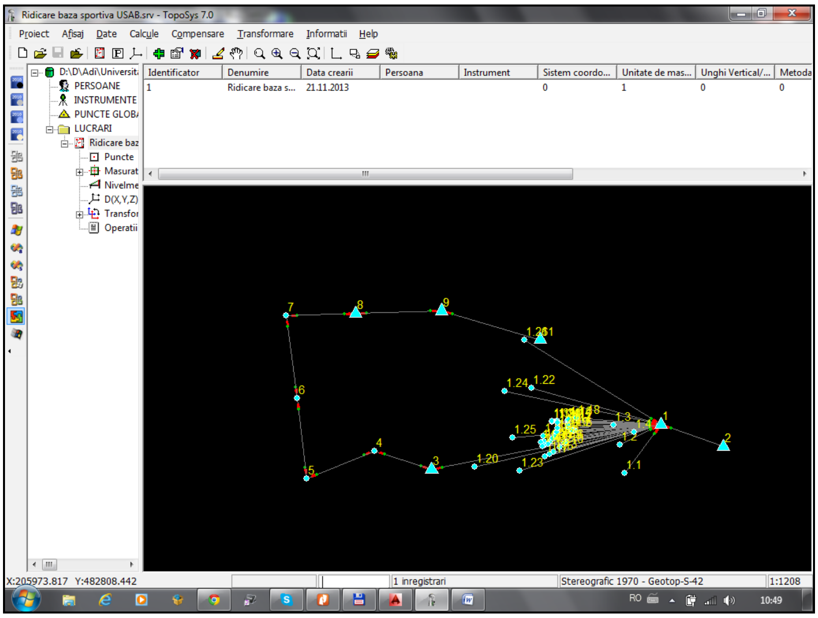

Figure 2. Reporting radiates for the station points S1

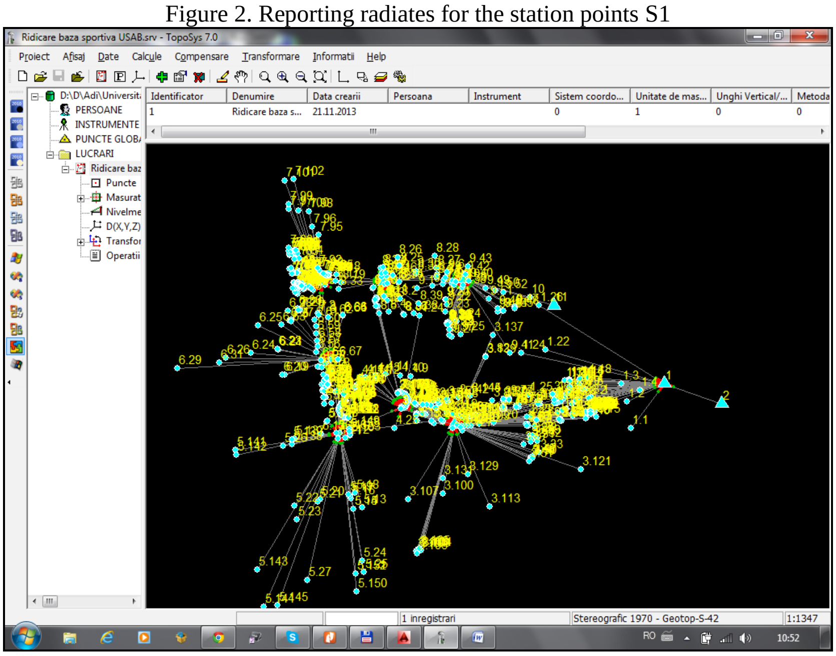

Figure 3. Reporting radiates for all the station points of the routing

For each station point there was made the compensation with the TopoSys software as showed in Figure 4.

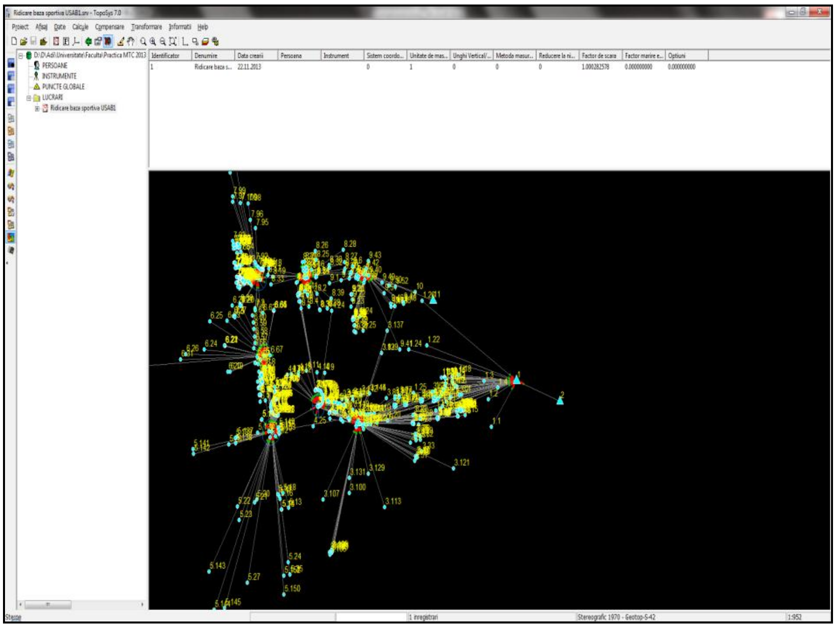

Figure 4. Compensation constrained by fixed points weighted by distance

Along with the compensation of the station points coordinates, TopoSys software generates the compensated values of the horizontal distances for all the routing points as shown in the table 5.

Table 5

Horizontal distance and compensated distance between station points of the routing

NPS	NPV	Horizontal distance [m]	Compensated distance [m]	V [cm]	τ
1	2	35.753	35.750	-0.303	0.048
1	3	126.124	126.135	1.145	0.182
3	1	126.121	126.135	1.449	0.230
3	4	32.466	32.445	-2.071	0.331
4	3	32.453	32.445	-0.791	0.126
4	5	39.686	39.723	3.691	0.589
5	4	39.692	39.723	3.114	0.497
5	6	43.684	43.650	-3.321	0.530
6	5	43.670	43.650	-1.994	0.318
6	7	45.109	45.065	-4.409	0.704
7	6	45.034	45.065	3.028	0.483
7	8	37.337	37.343	0.587	0.094
8	7	37.335	37.343	0.742	0.118
8	9	46.355	46.534	17.875	2.852
9	8	46.353	46.534	18.079	2.885
9	11	55.463	55.460	-0.311	0.050

Also the TopoSys software calculates the error ellipse for the each station points of the routing. An example it is shown in the figure 5.

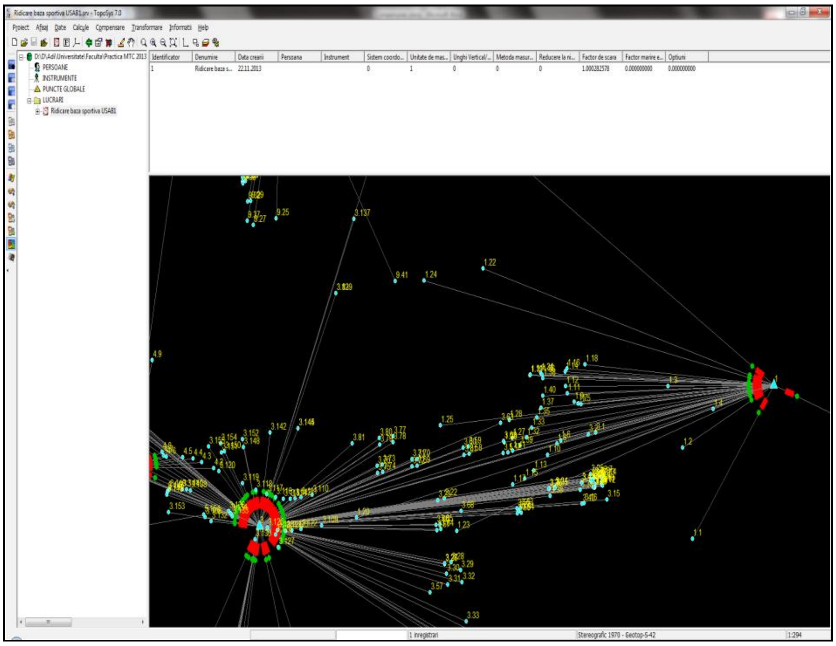

Figure 5. Error ellipse for the station points S1 and S3

CONCLUSIONS

The topographic survey presented in this paper was done on an area within the campus of the Banat's "King Michael I of Romania" University of Agricultural Science and Veterinary Medicine of Timisoara, Romania, an area that covers the sports grounds and the dormitories. Determining point coordinates was done with the topographic instruments Leica TC805 and Leica GeoSystems 1205+.

Data collected were downloaded with Leica GeoOffice Combined software and compensated with the TopoSys software to determine the best correction of the point coordinates measured. The coordinate processing method allows accuracy up to the order of centimetres. The coordinates of the compensated points were reported in AutoCAD with TopoLT programme operating on the AutoCAD platform.

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This paper is important because presents a situation plan of the area described above in order to identify details; the plan will be used in future works for different goals within the university.

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