LAND SURVEY FOR 3D REPRESENTATION OF THE DENDROLOGICAL PARK OF THE BUASVM IN TIMISOARA, ROMANIA

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Abstract

This paper presents the land survey for the 3D representation of the Dendrological Park of the Banat University of Agricultural Science and Veterinary Medicine of Timisoara, Romania, a park located between the building of the Faculty of Agriculture and Aradului Avenue. The land survey was made in spring, when the vegetation is not too abundant, thus easing the measurements and diminishing considerably the number of stations.

The dendrological park in which we made the land survey covers 34,183.32 m^2, an area on which, after we collected land survey details, the neighbouring parking lots and the contour of the park, we also surveyed the inner area of the park to produce the quota plan and the 3D model of the land; this survey was made every 25 steps on a square measuring 20x20 m, and for the entire area.

The land survey presented in this paper was made with a Leica total station series 805, whose accuracy of measuring angles is 5 cc and of measuring distances is 1 ppm. Processing data was done with a Leica Geo Office Tools software; later, the processed points were reported into Autocad and we made the situation plan. The land survey and the situation plans were made in the projection system Stereographic 1970.

Key words: land survey, 3D model, Leica Geo Office Tools, TopoLT, total station.

INTRODUCTION

Measuring the earth surface has been of great interest from times immemorial. Ever since the Antiquity, they aimed at creating measuring tools that facilitate human work. Every invention was the starting point for another invention, from such "primitive equipment" as the human step to extremely performing equipment such as the Total station or the GPS.

The spectacular results of the last decades in the achievement of modern geo-topo-photogrammetric equipment and tools have changed and improved continuously the methodology and technology of land survey. Their technical features recommend them as extremely performing from the point of view of their accuracy, yield, comfort, and safety in exploitation, which promoted them for their economic efficacy, as well.

As a principle, a *"total station"* or an *"intelligent station"* is an electronic tachymeter with which we can measure with accuracy, record automatically, and render digitally geometric elements (angles, distances, level differences). Being relatively new, these apparatuses belong to the new generation of electronics; they improve continually and materialise the ideal of specialists in the field: *a geo-topographic tool that allows high accuracy measurement of both angles and distances*, no matter their size.

MATERIAL AND METHOD

The land survey presented in this paper was made with a total station Leica series 805, whose accuracy in angle measurement is 5 cc and in distance measurement is 1 ppm. Data processing was done with a Leica Geo Office Tools software, and the points were later reported into Autocad with which we produced the situation plan. The 3D model of the land was made with a TopoLT programme, which functions under a CAD platform.

The 3D model of the land based on points whose coordinates are X,Y,Z or on lines and space polylines is done with the interpolating method when using the TopoLT programme, a programme that also uses the triangulation method with linear interpolation.

The advantages of the TopoLT programme in making 3D models are as follows:

- The 3D model can be done in gradual colours that vary from minimum to maximum quota (colour performance is limited to 256 colours in the CAD programme). Choosing minimum and maximum colour can be done using the programme configuration option;
- The points with a certain quota can be removed from the points selected to achieve the 3D model (implicit value for quota points is 0.000 m);
- To make a 3D model, we can select lines or polylines in which the 3D model has a forced slope change. The lines or polylines selected should go through topographic points whose coordinates are X,Y,Z or be drawn in space;
- The 3D model can be limited in a perimeter by selecting a polyline that separates the area on which we wish to create the 3D model. Through this limit, we need to cut the 3D model built through all selected points.

RESULTS AND DISCUSSION

1. Identifying the land and establishing the station points

After establishing properly the limits of the area on which the land survey should be made (Figure 1) and after choosing the apparatuses, we chose the station points to make the measurements. The station points were determined with a Leica series 1200 equipment and were called S100, S200 and S400 (Table 1).

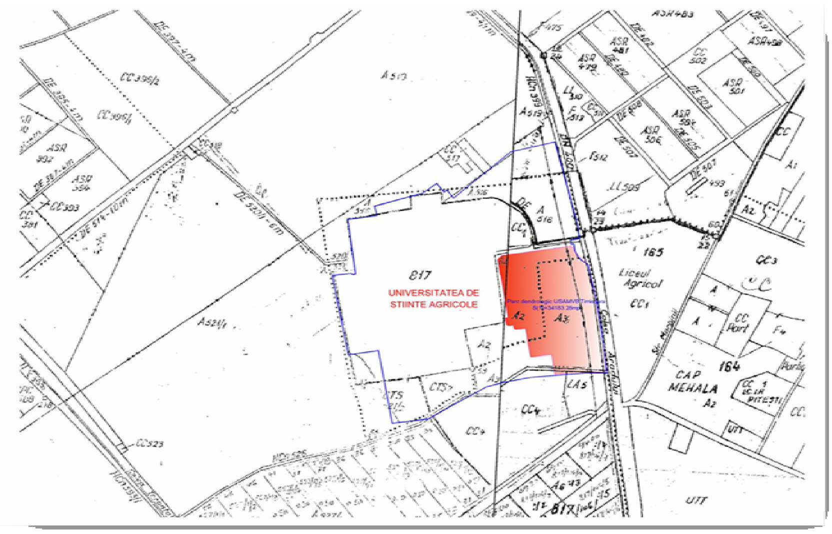

Fig. 1. Framing the dendrological aprk of the BUASVM in Timisoara

Table 1

GPS determined points

Station point	Land mark	X(m)	Y(m)	Z(m)
S100	Metal pin	482733.669	206119.060	90.276
S200	Metal pin	482738.679	206095.331	90.319
S400	Metal pin	482721.870	206152.805	90.036

2. Routing and removal of planimetric points

The land survey was made in a system of stereographic coordinates 1970. After orienting the apparatus towards the station point S200, we removed the station point S400. Then, we established the next station point for the routing. The routing we chose was a routing closed on the starting point. The next station (called S300) was read from the station S200 (Table 2); then, we started to raise the quota points for the 3D model of the park. To raise the quotas, we chose to create a square measuring 20x20 m, which meant the removal of the points every 25 steps. The next operation was establishing the next station S500 (Table 3).

Table 2

Coordinates of the points in the station point S200

Station point S200				
Support points		**X(m)**	**Y(m)**	**Y(m)**
S200	**Metal pin**	482738.679	206095.331	90.319
S100	Metal pin	482733.669	206119.060	90.276
S400	Metal pin	482721.870	206152.805	90.036
S300	Wood pale	482843.277	206141.870	90.008

Table 3

Coordinates of the points in the station point S300

Station point S300				
Support points		**X(m)**	**Y(m)**	**Y(m)**
S300	**Wooden pale**	**482843.277**	**206141.870**	**90.008**
S200	Metal pin	482738.679	206095.331	90.319
S500	Wooden pale	482894.012	206129.526	90.317

From the station point S300, after removing unnecessary points, we moved to the station point S500, where we operated the same operations, we directed towards the station point S300 which we removed and we checked the coordinates; we then chose the next point, i.e. S700 (Table 4).

Table 4

Coordinates of the points in the station point S500

Station point S500				
Support points		**X(m)**	**Y(m)**	**Y(m)**
S500	**Wooden pale**	**482894.012**	**206129.526**	**90.317**
S300	Wooden pale	482843.277	206141.870	90.008
S700	Wooden pale	482922.549	206145.061	90.415

From the station point S700, we followed the station point S500 and then aimed at the next station point S800 (Table 5).

Table 5

Coordinates of the points in the station point S700

Station point S700				
Support points		**X(m)**	**Y(m)**	**Y(m)**
S700	**Wooden pale**	**482922.549**	**206145.061**	**90.415**
S500	Wooden pale	482894.012	206129.526	90.317
S800	Wooden pale	482922.727	206093.251	90.610

From the station point S800 we followed the station point S700, and then we aimed at the next station point, S1000 (Table 6).

Table 6

Coordinates of the points in the station point S800

Station point S800				
Support points		**X(m)**	**Y(m)**	**Y(m)**
S800	**Wooden pale**	**482922.727**	**206093.251**	**90.610**
S700	Wooden pale	482922.549	206145.061	90.415
S1000	Metal pin	482938.144	206035.965	90.089

From the station point S1000 we followed the station point S800, and then aimed at the next station point, S1100 (Table 7).

Table 7

Coordinates of the points in the station point S1000

Station point S1000				
Support points		**X(m)**	**Y(m)**	**Y(m)**
S1000	**Metal pin**	**482938.144**	**206035.965**	**90.089**
S800	Wooden pale	482922.727	206093.251	90.610
S1100	Metal pin	482893.383	206061.410	90.269

From the station point S1100 we followed the station point S1000, and then we aimed the next station point, S200 (Table 8).

Table 8

Coordinates of the points in the station point S1100

Station point S1100				
Support points		**X(m)**	**Y(m)**	**Y(m)**
S1100	**Metal pin**	**482893.383**	**206061.410**	**90.269**
S1000	Metal pin	482938.144	206035.965	90.089
S200	Metal pin	482738.679	206095.331	90.319

From the station point S200 we followed the station point S1100, and then aimed at the next station point, S100 (Table 9).

Table 9

Coordinates of the points in the station point S200

Station point S200				
Support points		**X(m)**	**Y(m)**	**Y(m)**
S200	**Metal pin**	**482738.679**	**206095.331**	**90.319**
S1100	Metal pin	482893.383	206061.410	90.269
S100	Metal pin	482733.669	206119.060	90.276

The routing was closed from the station point S100, from which we followed the station point S200 and read the station point S400 (Table 10).

Table 10

Closing of the routing on the station point S100

Support point		**X(m)**	**Y(m)**	**Y(m)**
S100	GPS determined	482733.669	206119.060	90.276
S100	Differences upon closure	-0,011	0,119	0,071

3. Downloading

Downloading consisted in coupling it through a data transfer cable with a computer. The programme we used is Leica Survey Office Tools. With this programme, we downloaded the job (the points measured) from the apparatus into a file whose extension was .GSI.

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JOB NAME  "PARC DEND"
OPERATOR : SMULEAC
Data of execution :  16. 04.2013
|   Pct  |   Hz   |   V   |   SD   |   HD  | hr/hi |   XXX   |   YYY   |   ZZZ  | COD |  Descriere
|
| St: S100 | -------- | -------- | -------- | -------- | 1.376 | 482733.669 | 206119.060 |   90.276 | --- | -------- |
| Or: S200 | 313.2235 | -------- | -------- | -------- | ----- | ---------- | ---------- | -------- | --- | ---------------- |
|    S101 | 313.2252 |  99.5802 |   24.256 |   24.255 | 1.500 | 482738.672 | 206095.326 |   90.312 | ---- |
|    S300 |  13.0678 | 100.0796 |  111.954 |  111.954 | 1.500 | 482843.273 | 206141.880 |   90.013 | --  |
|    1000 | 118.5832 | 100.0784 |   40.958 |   40.957 | 1.500 | 482721.882 | 206158.285 |   90.102 |  04 |
|    1001 | 140.7998 | 100.1032 |   52.604 |   52.604 | 1.500 | 482702.217 | 206161.226 |   90.067 |  04 |
|    S400 | 121.3938 | 100.0203 |   35.747 |   35.747 | 1.500 | 482721.881 | 206152.807 |   90.141 |  01 |
|    1002 | 110.3803 | 100.0425 |   62.408 |   62.408 | 1.500 | 482723.538 | 206180.640 |   90.111 |  25 |
|    1003 | 127.1040 |  99.8235 |   66.781 |   66.781 | 1.500 | 482706.088 | 206179.880 |   90.337 |  25 |
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4. Making situation plans after data processing

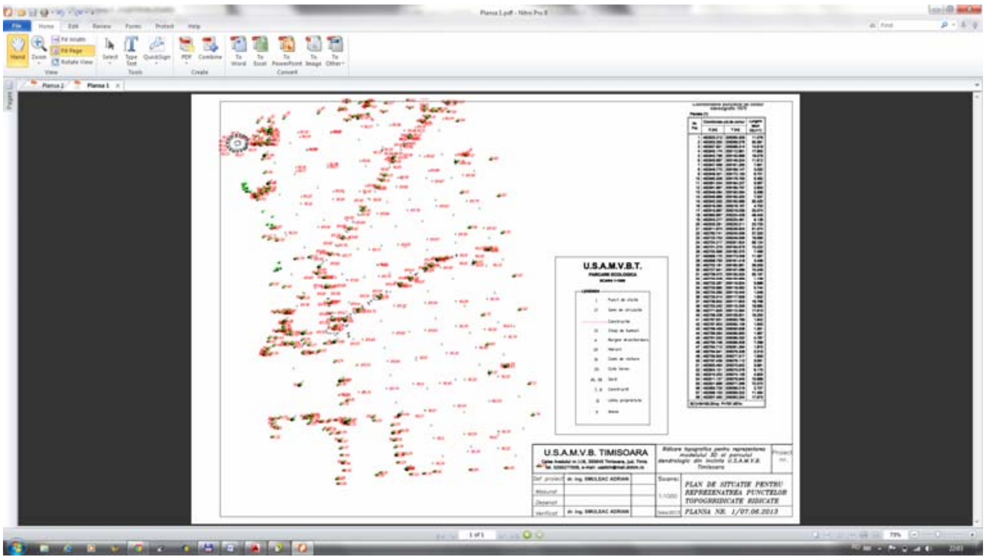

Fig. 2. Situation plan with quota representation

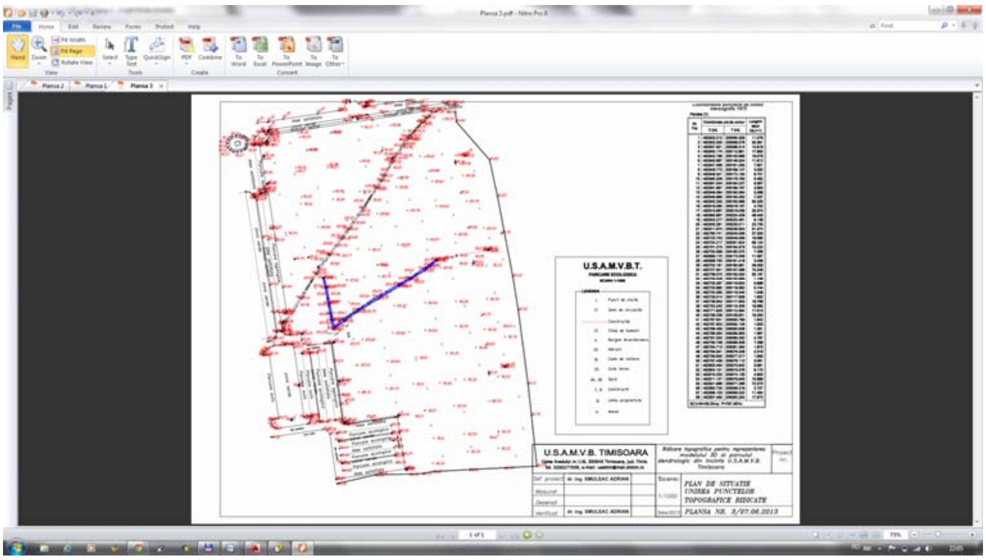

Fig. 3. Situation plan after linking the points

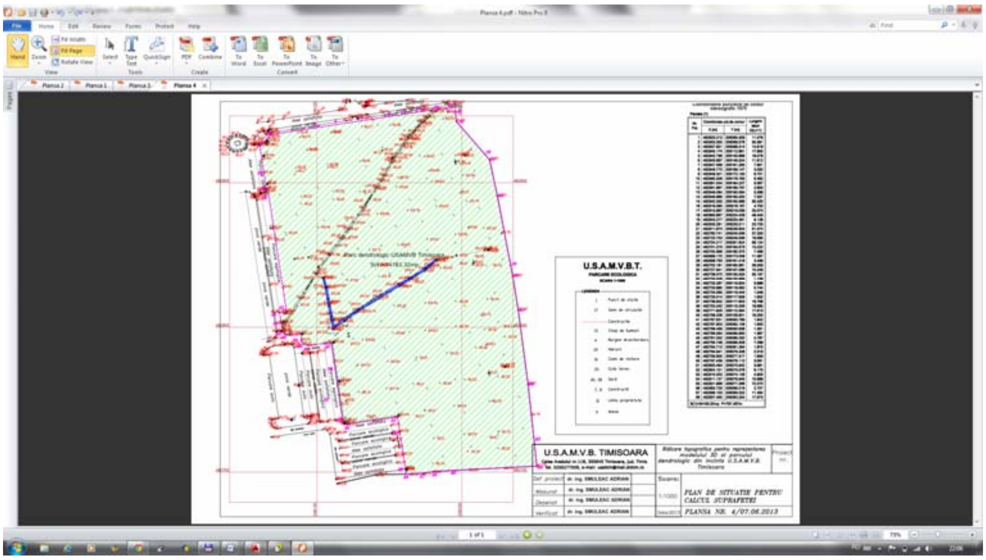

Fig. 4. Situation plan for area representation

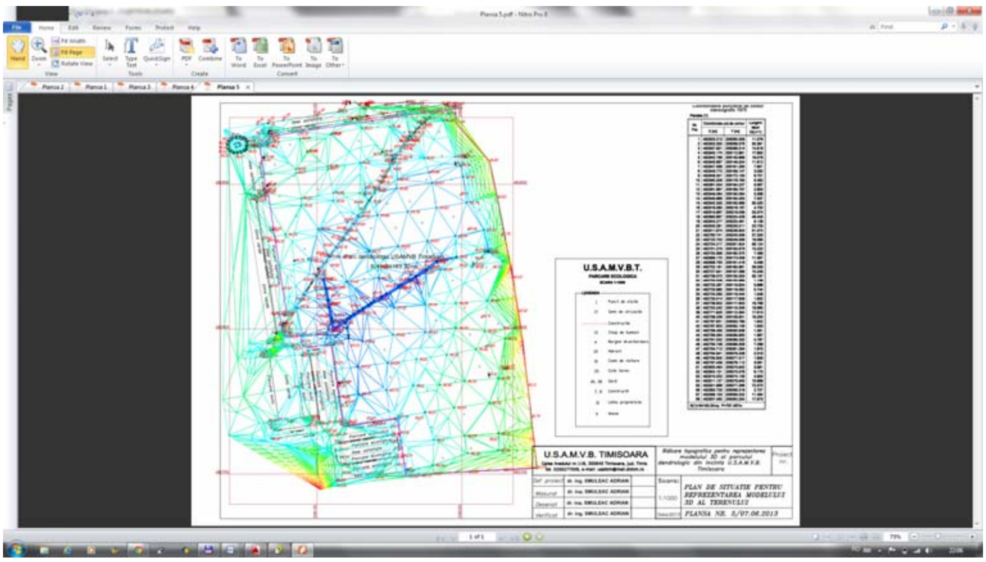

Fig. 5. Situation plan for land 3D model

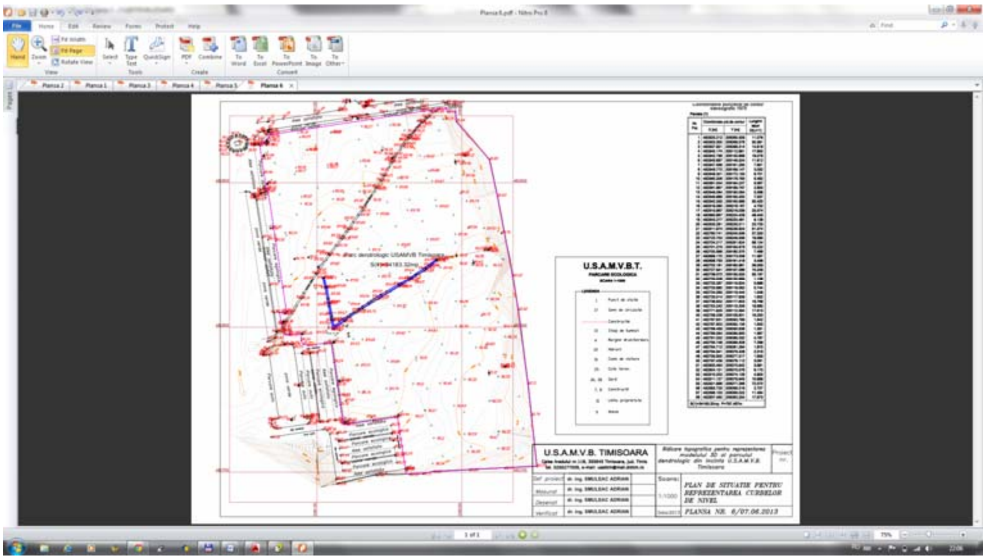

Fig. 6. Situation plan with curve levels

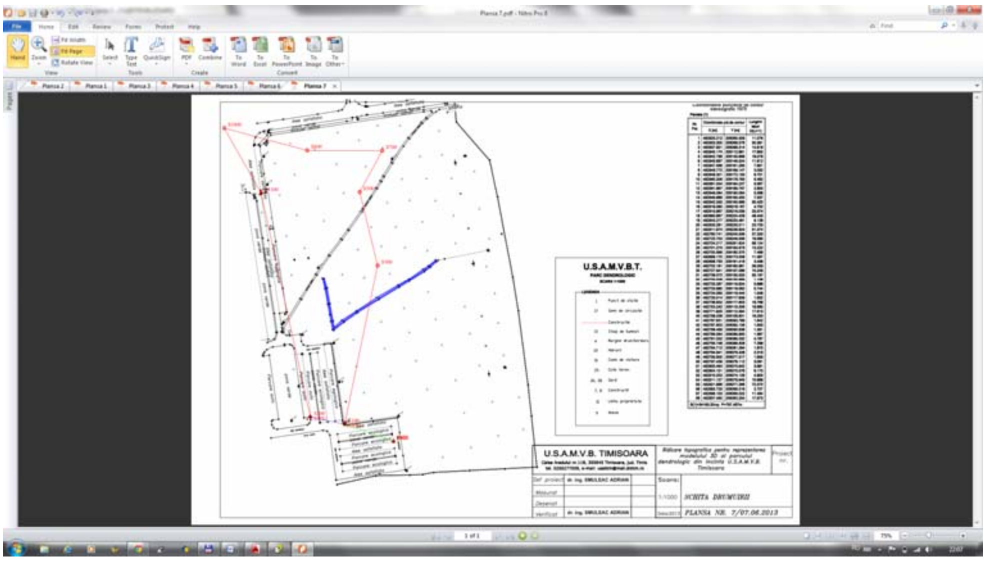

Fig. 7. Situation plan with routing sketch

CONCLUSIONS

Linear interpolation is one of the methods frequently used to produce a **Digital Terrain Model (DMT)** of the raster type starting from the level curves of a topographic map. The quality of the model is debatable because there are obvious errors. The histogram of such a model looks like a lace surface with several peaks that correspond to the values of the level curves, which shows that the data have a higher density along the isolines than in the space between them, the model having the "print" of the initial topographic map.

Generating a digital terrain model refers to the way of data acquisition, to the achievement proper of the model through different interpolation methods, as well as to the choice of the data representation structure (raster or TIN).

The interpolation methods of the **triangulation** type that produces a **TIN** structure **(Triangular Irregular Network)** are also multiple. The best is ***Delaunay interpolation***, which allows the production of triangles perfectly circumscribed to circles through which the distance between the points that make up the triangle points is always minimum.

For each triangle, we memorise the coordinates and attributes of the three points, the topology and the slope and slope direction of the triangle area.

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