

APPLICATION OF LASER SCANNING FOR TERRAIN MODELING OF TECHNOGENIC ZONES

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there appeared a cloud of dust, which settles during 5-10 minutes.

Statement of the problem

At present, voluminous well-detailed 3D-terrain models replace the two-dimensional cartographic materials. The increase in the number of large projects in this area can demonstrate this tendency well. As a striking example here serves a project directed on creation of a 3D model of the surface (relief) of slagheaps.

Properties of the object:

- survey area of about 70 hectares;
- maximum height difference does not exceed 60 m;
- most part of the territory consists of slag mounds of various sizes;
- on the territory of the object the planned works on unloading and removal of blastfurnace slag are constantly held.

After getting acquainted with different materials on the object and having conducted a reconnaissance of the terrain, it is necessary to determine the method of recording and the software for measurements processing.

Analysis of recent studies and publications

There are enough materials to solve such problems. Notable here is the fundamental difference in the methods of data gathering, while processing algorithms remain similar. The most widely used is the method of aerial photography, in which it is possible to use both stereophotogrammetric technologies and photographing with one camera at a sufficiently large number of visitations on the object.

Methods of laser scanning (LS) and land surveying are rarely used for such tasks. The LS result is excessively informative, and in some cases it complicates processing operations. Land surveying often acts as a specific information and an addition to the materials of the aerial photographs, thus confirming the expediency of a combination of methods of information gathering for more complete data.

Unresolved part of the problem

The object has a complex geometry with multiple projections, depressions and mounds. The work is complicated by a large number of equipment operating on the territory of slagheaps, and by the presence of buildings and vegetation (Fig.1.). At trucks movement



Fig. 1. The depiction of the object

The high cost and properties of the object make the usage of aerial photography as a method of information gathering inappropriate. Whereas the combination of laser scanning and GNSS-technologies will maximize the completeness and the quality of data, which will simplify the processing operations.

Statement of the task

The development of a method of combining GNSS-technologies and LS in order to increase the information content of data and the rate of the field works.

The creation of nodal points in a given area with the help of a permanent network of GNSS-stations enabled:

- to monitor accuracy;
- to bind the point cloud to a required coordinate system (CS) with a minimum error;
- to connect the object's segments in a single database.

The choice of the software for LS data processing, supplements with GNSS-data, creation of a Tin-model and calculating the volume of blastfurnace slags.

Statement of the basic material

As a part of the project of creating a 3D-model of the slagheaps surface the following steps have been identified:

- laser scanning and surveying of the territory of slagheaps by a GNSS-receiver;
- creation of reference points;
- binding the point cloud to the factory coordinate system;

- processing of field measurements (cross-linking of the scans into a single point cloud, clearing the point clouds from the noise, data supplements with GNSS-survey data);
- creation of a detailed Tin-terrain model.

Field measurements

Before the beginning of the fieldworks the object has been conditionally divided into 9 sections, thus scanning each of them will take no more than 10 hours. The scanning step has been set, depending on the distance and the viewing angle. It should be noted that bright sunlight had not affected the results of the survey. There have been found some minor flaws, related to the visibility of the object by the scanner at a distance over 180 m., and the presence of noise due to the working procedures on the object, but in general the results of the works are positive.

In order to control the measurements, to clarify the contours and the survey of difficult accessible places, there has been applied a GNSS-receiver GS08 NetRover manufactured by Leica Geosystems (Switzerland). The resulting material in some cases allowed to supplement the point cloud and to minimize the size of the "blind spot."

In general, there have been carried out more than 300 scan positions. As a result there have been obtained more than 190 million coordinate points (Fig. 2).

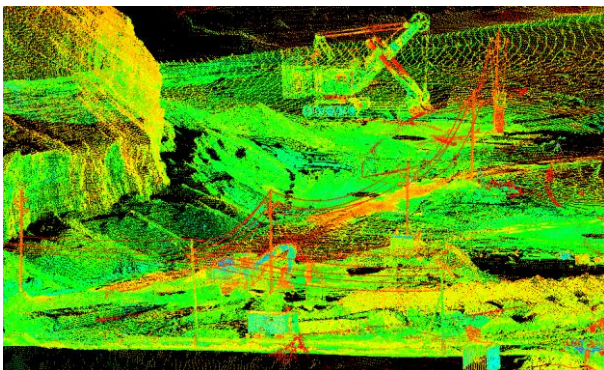


Fig.2. Part of the point cloud

Creating a survey justification

In order to determine the coordinates of reference points, it has been decided to use a network of permanent basic GNSS-stations – System.NET as starting points. The determination of the coordinates of supporting geodetic equipment points has been performed with the help of dual-frequency geodetic GNSS-receivers, the binding scheme is shown in Fig. 3.

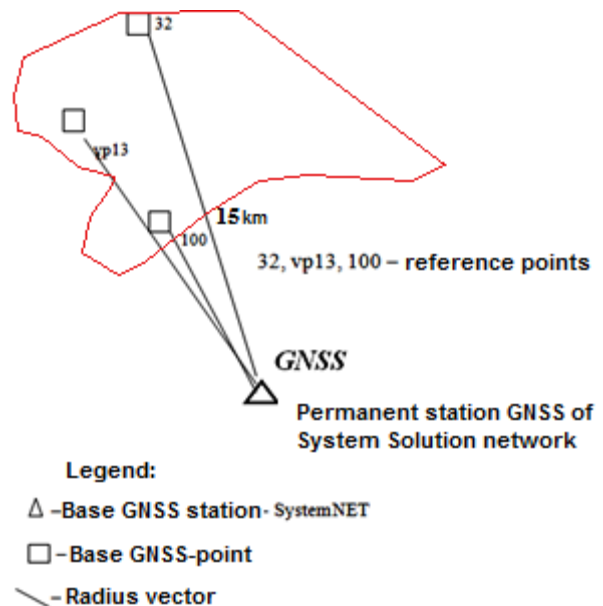


Fig. 3. The binding scheme of reference points

Before the beginning of the field phase of the survey, there has been carried out a detailed analysis, and the methodology of GNSS-measurements, which appeared to be the most satisfying for accuracy requirements, has been chosen. The static survey mode, which is used, first of all, to create, high-precision geodetic justifications, has fully satisfied the requirements of this work.

The periods of observation sessions were planned before the beginning of the field works, using the software Leica Geo Office v.7.0.1. (Leica Geosystems), and Pinnacle (TOPKON). The observation sessions have been carried out by two basic receivers to provide the project with the data required for the equalization. The duration of the observation session has been determined, taking into account the desired accuracy of measurements and the length of the baseline. The duration of the session has lasted at least 40 minutes at the baseline length of 15 km. The number of the satellites is at least seven (on average 11-12).

The processing of GNSS field measurements has been carried out, using the software (Leica Geo Office v7.0.1).

Office studies

In the course of the office studies the following works have been carried out:

- cross-linking the individual scans into a single point cloud, using the Cyclone-REGISTER module;
- binding the cloud to the factory CS;
- clearing the point cloud from the noise caused by equipment and people, which was accidentally caught in the scanning area. The result was an objective stacks model of a multi-million point cloud (Fig. 4);

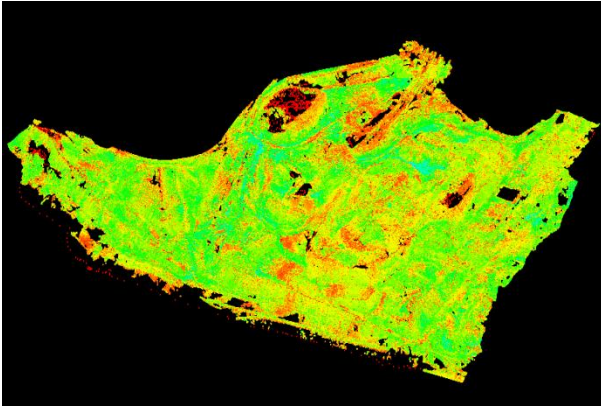


Fig. 4. The point cloud cleared from the noise

- supplement of the point cloud with the GNSS-survey data.

The final stage in the office studies was the creation of a Tin-model. A good level of the detailing (no blurry areas) and the completeness have been basic requirements of the project. The algorithms of creating and editing mesh in the software product 3DReshaper have fully allowed to carry this task out (Fig. 5).

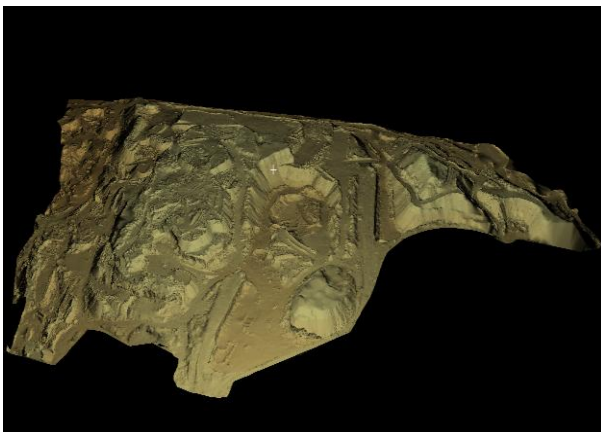


Fig. 5. The image of a Tin-model of slag piles

Conclusions

The field works have taken 12 days, including laser scanning and GNSS-survey. During the process the correctness of the use of laser scanning technology for this direction of geodetic works has been confirmed, as LS provides the most complete and accurate field data about the object.

The importance of combining the techniques of survey should be noted. Due to the use of GNSS-technologies, it has become possible to avoid the problems, connected with the detailing of surfaces thickly overgrown with vegetation, while allowing to preserve the completeness of information.

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Application of laser scanning for terrain modeling of technogenic zones

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Shows and describes a process for combining laser scanning and GNSS technologies for use in 3D modeling of relief technogenic areas applications.