

The application of terrestrial laser scanning for spatial visualization of laboratories of the BERG faculty

Katarína Pukanská¹

This paper deals with current technological possibilities in surveying for fast measurement of objects – buildings, interiors, exteriors and their almost immediate visualization or further planning of changes – reconstruction, preparation of design documentation for various technological interventions. Technological development in the field of surveying instruments and their accessories is focused on fast acquisition of spatial information about the position of objects and as simple as possible processing of them into the form of 3D objects, views, cross-sections and cross-sectional views in a form of 2D drawings. Four laboratories were measured by terrestrial laser scanner Leica ScanStation C10 for the needs of the Faculty of BERG, which were subsequently processed and modeled in the SketchUp Software, that enables freely available computer modeling and rapid display of components, making up a realistic presentation of survey.

Key words: terrestrial laser scanning, SketchUp, objects modeling.

Spatial survey

The current technological development provides increasingly more powerful technologies for fast and accurate measurement of objects and almost immediate visualization. In surveying, it is mainly about digital close-range photogrammetry and terrestrial laser scanning. Nowadays, it is almost impossible to make documentation of historical monuments, archaeological and historical research, but also of modern investment construction without these technologies [6].

In the process of creation of spatial models of laboratories a request of surveying and modeling of four laboratories of the Faculty of Mining, Ecology, Process Control and Geotechnology (BERG) was specified. The measurement itself was realized by the use of Leica ScanStation C10 (Fig. 1, Tab. 1), a full panoramic high-speed pulse laser scanner determining measured distance by the transit time – Time of Flight (ToF) technology.



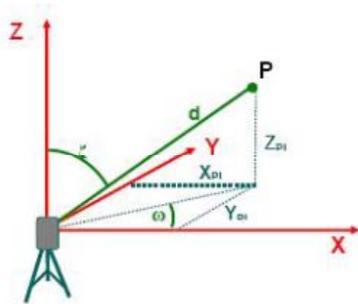
Fig. 1. TLS Leica ScanStation C10.

Tab. 1. Technical specification of Leica ScanStation C10.

Technical specification of the laser scanner	
Accuracy of single measurement	
Position/Distance	6 mm/4 mm
Angle precision	
Horizontal/Vertical	12'' / 12''
Modeled surface precision	2 mm
Range	300 m @ 90%; 134 m @ 18%
Minimal step of scanning	1 mm
Scan rate	50 000/sec.
Laser class	3R, green ($\lambda = 532$ nm)
Spot size	0-50 m \approx 4,5 mm
Field of view	
Vertical/Horizontal	270°/360°

The device is compact with an integrated camera; laser beam is deflected on the principle of rotating mirror. Coordinates of measured points are calculated on the principle of spatial polar method (Fig. 2) [5, 8], while in the coordinate system of the device, which origin is at the center of the scanner, the horizontal position ω and vertical position ζ of emitted bundle of laser beam and transit time required to determine a measured distance d is measured. The resulting position of the measured point is computed from the formula (1,2,3) [4, 9]:

¹ MSc. Katarína Pukanská, PhD., Technical University of Košice, Faculty of Mining, Ecology, Process Control and Geotechnologies, Institute of Geodesy, Cartography and Geographic Information Systems, Letná 9, 042 00 Košice, katarina.pukanska@tuke.sk



$$x = d \cdot \cos(\omega) \cdot \sin(\zeta) \quad (1)$$

$$y = d \cdot \sin(\omega) \cdot \sin(\zeta) \quad (2)$$

$$z = d \cdot \cos(\zeta) \quad (3)$$

Fig. 2. The principle of spatial polar method.

Processing in the Leica Cyclone software

Fast scanning with a high density of points produces large files. Good quality software plays a crucial role in the processing of data obtained by terrestrial laser scanner, which makes it easier to process, but also to export measured data to exchange formats. Manufacturers usually supply software packages directly with technological devices. The Cyclone firmware is bundled together with Leica ScanStation C10, through which it is possible to control the scanner – set the range and density of scanning, data filtering and scripting of scanning. In the computer environment it allows to import measured data, crop these data of unnecessary points, display data in the form of the intensity of reflected laser beam (Fig. 3), as well as with added texture information in the RGB color model (red, green, blue) (Fig. 4), and consequently it allows to model objects by using simple mathematical solids like plane, sphere, cylinder and cone.

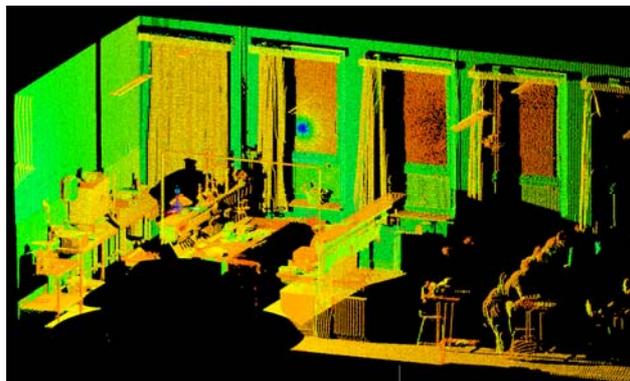


Fig. 3. View of the measured data of laboratories by the intensity of reflected signal.

This way prepared data can be then visualized, modeled to 3D, extracted, analyzed and shared in the CAD systems in several exchange formats [1, 2, 3]. Export via TrueView Publisher application supports for example web sharing through server and display in the web browser Microsoft Explorer, where one database can be accessible to multiple users who are allowed to remotely recharge data, notes and make direct measurement on point cloud.

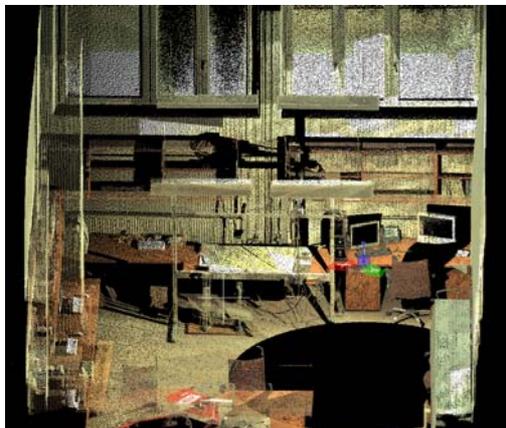


Fig. 4. Display of the point cloud in the form of RGB composition.

Scanning was realized in each laboratory from one survey station, with full panoramic range setup, scanning density of 2 cm on 5 m distance, which was fully sufficient for the needs of quality processing. As the visualization itself was realized in the SketchUp software, only import of data, cropping of unwanted and unnecessary points and export into the web interface Microsoft Explorer was carried out in the Cyclone software.

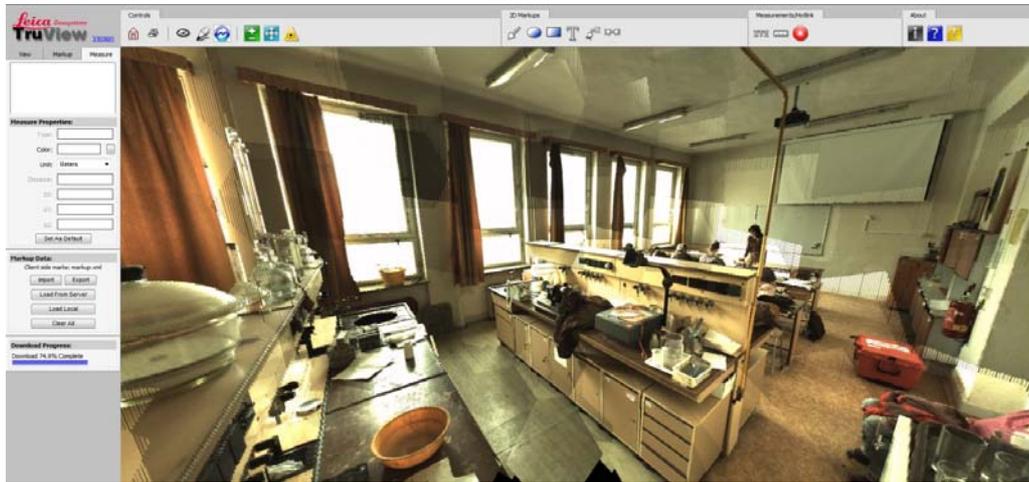
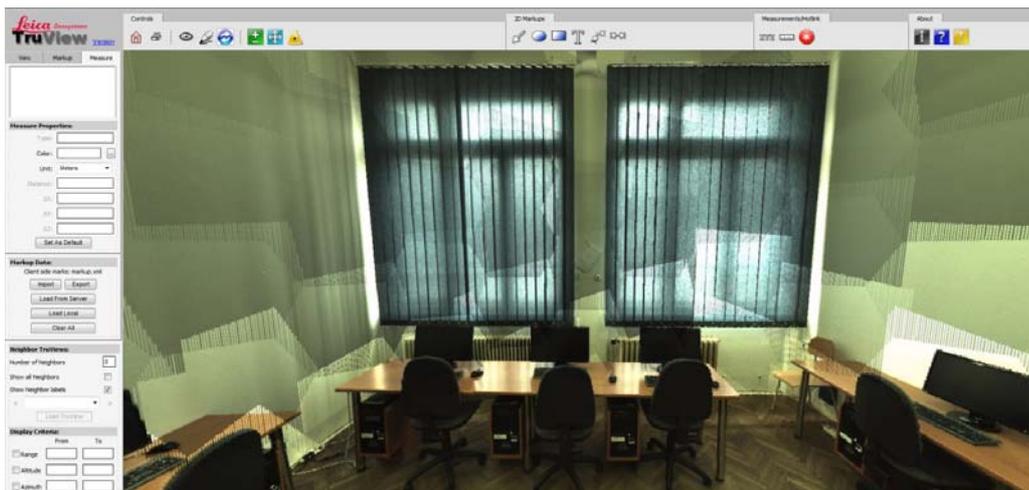
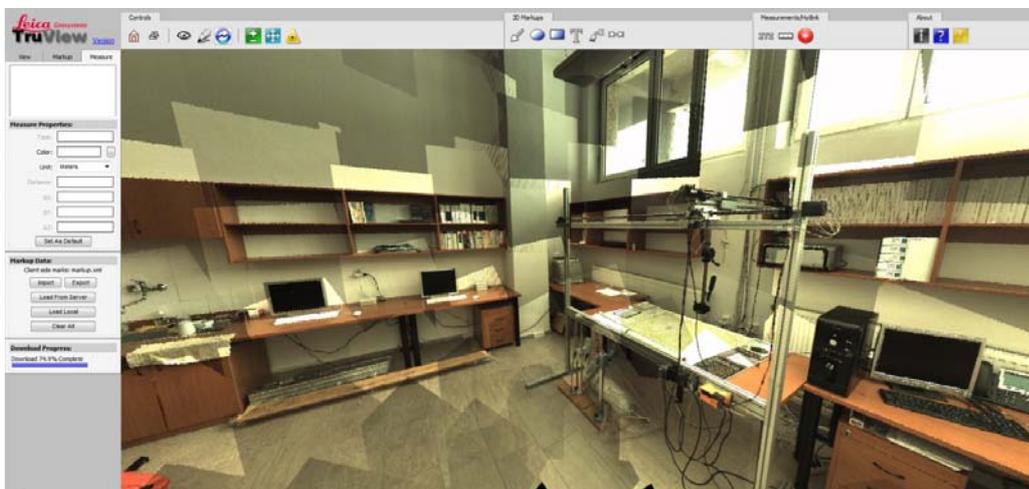


Fig. 5. Exported measured data to Leica TrueView and shared display in a web browser a, M3 laboratory



b, KGM 4 laboratory



c, LDOP laboratory.

Visualization in the SketchUp software

Current trend in computer visualization offers almost unlimited software possibilities for creating spatial models – from freely available software applications such as Trimble SketchUp (Fig. 6), to sophisticated, complicated and mostly expensive type of software like Autodesk 3D max Studio, Maya, AutoCAD, Bentley Microstation and others.

Due to time and software options, we decided to process the measured data in the Trimble SketchUp 8 software, which is fast, intuitive and allows to visualize objects, interiors and buildings with minimal effort. It is a simple, freely accessible platform with basic drawing, imaging and manipulation tools. In addition to freely distributed version, there is also available a professional, paid version SketchUp Pro, which has more advanced options for 3D drawing, sharing and exporting of drawings between other modeling software into the formats 3DS, DWG, DXF, OBJ, XSI, VRML and FBX as well as creation of corresponding 2D drawings from created models [10].



Fig. 6. A variety of tools in Trimble SketchUp 8.

The simplicity of this application lies in drawing of lines, curves, 3D curves, circles, polygons, text writing, dimensioning, creating cross-sections, but also sharing a number of 3D components, created by worldwide users, who share them together and freely distribute by using Trimble 3D Warehouse application (Fig. 7). Moreover, original textures from images can be mapped directly on the objects.

In the case of laboratories of Faculty of BERG, their geometric parameters were exported to the design file, where the individual components forming interior were inserted by modular system.

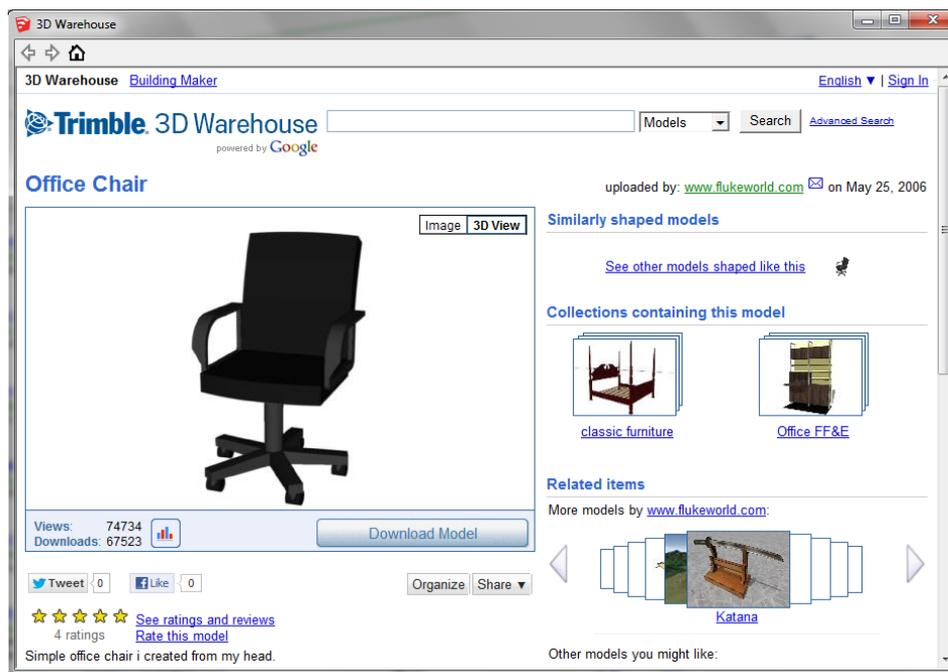


Fig. 7. Trimble 3D Warehouse and searching of online components.

Imported components are then freely inserted into the 3D drawing, where the necessary positions and scales are assigned to them. The size of free available database creates a really wide area for creative effortless modeling, approaching reality.

Toolbar buttons in Fig. 9-12 allow interactive browsing of objects in Adobe Reader software since version 9 and newer. We can virtually study these objects closer by using functions like rotate, pan, zoom, flyover, setting the visibility and lightning.

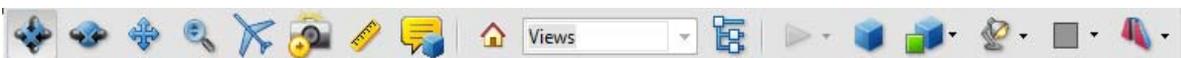


Fig. 8. Toolbar buttons in Adobe Reader.



Fig. 9. Visualization of LDOP laboratory. [Interactive 3D version of this figure.](#)



Fig. 10. Visualization of Geodetic laboratory. [Interactive 3D version of this figure.](#)



Fig. 11. Visualization of KGM-4 laboratory. [Interactive 3D version of this figure..](#)



Fig. 12. Visualization of K-3 laboratory. [Interactive 3D version of this figure.](#)

Conclusion

In conclusion we can say that the currently established trend of obtaining fast and accurate spatial information by laser scanning becomes fully competitive with conventional survey method and technologies, such as measuring by electronic total station or tacheometry. Accuracy 4 mm in position, 2 mm in the final modeled surface and scan rate of 50 000 points/sec. makes the new generation of laser scanner leaders in efficiency, quality and visual outcome. Their use in forensic analysis, crash tests, documentation of insurance accidents, but also anywhere, where is a need for fast and accurate measurement and presentation of almost immediate results is quite common nowadays [7, 10, 11].

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