3D terrestrial laser scanning for cadastral and design activities - performing, data processing and analysis. Storage and backup in the light of the nowadays cloud possibilities

Chief Assist. Prof. Dr.-Eng. Gintcho Kostov

University of Forestry, Bulgaria

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1. Introduction

3D Terrestrial laser scanning

fast and accurate contactless technology

IT – constantly evolving

New horizons and technological possibilities for the geodesists

data from the measurements could be used for more than one task

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1. Introduction

Nowadays

it is of significant importance / necessary the
usage of reliable encrypted backup (in the cloud)

secure data sharing (via link)

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2. Key parts of the workflow

-Preparation for performing of geodetic measurements with laser scanner in a villa area;

-Conducting productive one-person crew geodetic measurements;

-Processing of the raw data and analysis of the information;

-Georeferencing of the point cloud;

-Quality assessment;

-Extraction of the necessary information from the point cloud;

-Safe /encrypted online backup of the raw and processed data.

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3. Technological components of the procedure

In this study were involved:

-3D terrestrial laser scanner for performing geodetic measurements;
-Trimble RealWorks;
-Optical Internet;
-Contemporary laptop;
-Several cloud service providers.

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4. Geodetic activities in the field

a) setup of appropriate relation between quality/resolution in the scanner

b) the scanner was placed in a position, ensuring visibility to the object's details

c) clear view was ensured between the scanner and the artificial targets

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5. Requirements in the area of the IT

a) contemporary powerful laptop

b) optical Internet

c) security of the data (encryption)

d) cloud storage service accounts in different providers

6. Advantages of 3D terrestrial laser scanning in this specific case

a) all necessary cadastral details (outdoor and indoor) were measured in a **reasonable time** in the field

b) the terrain data around the object were also measured in the **same time**

c) **one person** was required to operate in the field

d) **enormous** field productivity was obtained

e) **significant accuracy** of the results

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7. Factors to be considered before performing of 3d terrestrial laser scanning for this case

a) geometry of the interior/exterior of the object

b) positions of the scanner

c) the area around the scanner and spheres to be clear

d) appropriate distances between:

-outdoor and indoor details/edges of the object
-each scanner's station

7. Factors to be considered before performing of 3d terrestrial laser scanning for this case

e) the required direct visibility:

-scanner - artificial targets
-scanner - object

f) the mutual spatial geometry of the spheres

g) appropriate settings for outdoor/indoor scans

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8. Processing of the raw data. Results

“Auto-extract Targets and Register” option was applied for data processing

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Registration Details

Station View | Advanced | Overall residual error: 0.001 m

Match with... | Unmatch | Auto-match all | Auto-match Station

Matched Station

Name	Scan Per ...	Correspond...	Scan Per Tar...	Residual Error	Delta N	Delta E	Delta El	Fitting Error	Distance to Sca...
MV001	**5**			**0.001 m**					
003		003	3	0.001 m	0.000 m	0.000 m	0.001 m	0.000 m	6.788 m
Target2		--	--	--	--	--	--	0.000 m	6.730 m
005		005	3	0.001 m	-0.001 m	-0.000 m	-0.000 m	0.000 m	7.911 m
002		002	3	0.001 m	0.001 m	0.000 m	-0.001 m	0.000 m	10.074 m
004		004	3	0.001 m	-0.000 m	0.000 m	0.001 m	0.000 m	7.614 m
MV002	**5**			**0.001 m**					
001		001	2	0.002 m	0.000 m	0.000 m	-0.002 m	0.000 m	12.650 m
002		002	3	0.001 m	-0.001 m	-0.000 m	0.001 m	0.000 m	4.099 m
003		003	3	0.001 m	0.001 m	-0.000 m	-0.000 m	0.000 m	9.302 m
004		004	3	0.000 m	-0.000 m	-0.000 m	0.000 m	0.000 m	8.087 m
005		005	3	0.001 m	0.000 m	0.000 m	0.001 m	0.000 m	6.339 m
MV003	**5**			**0.001 m**					
001		001	2	0.002 m	-0.000 m	-0.000 m	0.002 m	0.000 m	7.597 m
004		004	3	0.001 m	0.000 m	-0.000 m	-0.001 m	0.000 m	11.247 m
005		005	3	0.001 m	0.000 m	0.000 m	-0.000 m	0.000 m	8.710 m
003		003	3	0.001 m	-0.001 m	0.000 m	-0.001 m	0.000 m	12.187 m
002		002	3	0.000 m	0.000 m	-0.000 m	0.000 m	0.000 m	7.346 m

Fig. 1 Registration of the stations and quality assessment of the results

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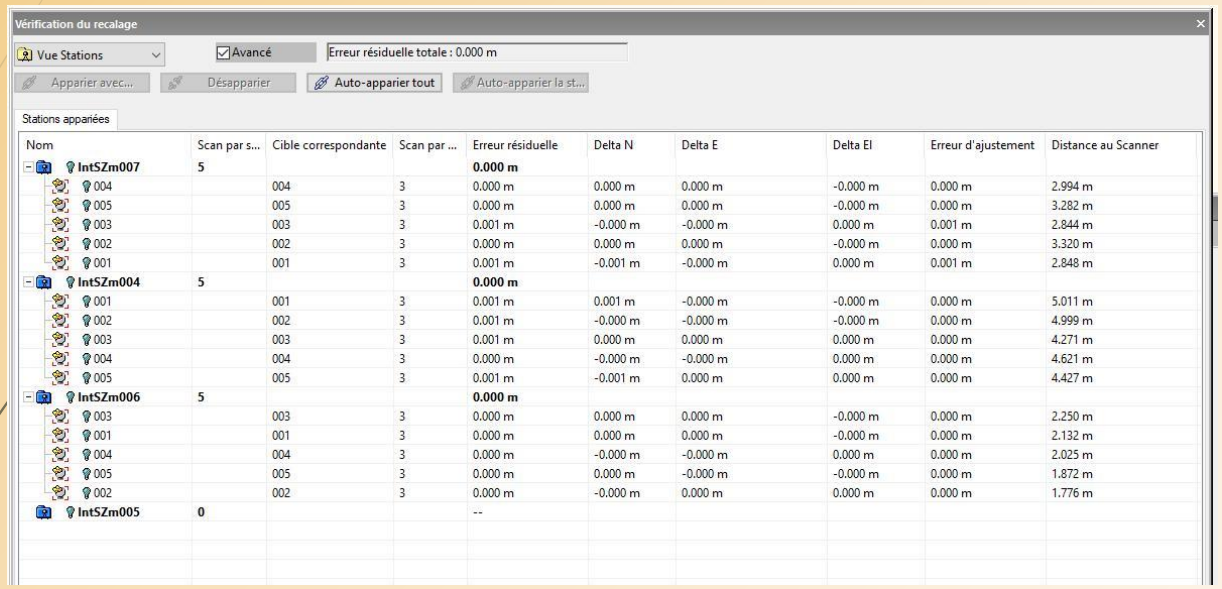
8. Processing of the raw data. Results



Nom	Scan par s...	Cible correspondante	Scan par ...	Erreur résiduelle	Delta N	Delta E	Delta El	Erreur d'ajustement	Distance au Scanner
IntSZm007	**5**			**0.000 m**					
004		004	3	0.000 m	0.000 m	0.000 m	-0.000 m	0.000 m	2.994 m
005		005	3	0.000 m	0.000 m	0.000 m	-0.000 m	0.000 m	3.282 m
003		003	3	0.001 m	-0.000 m	-0.000 m	0.000 m	0.001 m	2.844 m
002		002	3	0.000 m	0.000 m	0.000 m	-0.000 m	0.000 m	3.320 m
001		001	3	0.001 m	-0.001 m	-0.000 m	0.000 m	0.001 m	2.848 m
IntSZm004	**5**			**0.000 m**					
001		001	3	0.001 m	0.001 m	-0.000 m	-0.000 m	0.000 m	5.011 m
002		002	3	0.001 m	-0.000 m	-0.000 m	-0.000 m	0.000 m	4.999 m
003		003	3	0.001 m	0.000 m	0.000 m	0.000 m	0.000 m	4.271 m
004		004	3	0.000 m	-0.000 m	-0.000 m	0.000 m	0.000 m	4.621 m
005		005	3	0.001 m	-0.001 m	0.000 m	0.000 m	0.000 m	4.427 m
IntSZm006	**5**			**0.000 m**					
003		003	3	0.000 m	0.000 m	0.000 m	-0.000 m	0.000 m	2.250 m
001		001	3	0.000 m	0.000 m	0.000 m	-0.000 m	0.000 m	2.132 m
004		004	3	0.000 m	-0.000 m	-0.000 m	0.000 m	0.000 m	2.025 m
005		005	3	0.000 m	0.000 m	-0.000 m	-0.000 m	0.000 m	1.872 m
002		002	3	0.000 m	-0.000 m	0.000 m	0.000 m	0.000 m	1.776 m
IntSZm005	**0**			--					

Fig. 2 Registration results for the stations in the interior of the object

8. Processing of the raw data. Results

high accuracy obtained - overall residual error - **0.001 m.**

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Registration Report (using TZF Scans)

Name	Cloud-to-Cloud Error	Coincident Points (%)	Confidence (%)
ExtGraph			
extSZ001			
extSZ002	0.001 m	63%	100%
extSZ003	0.001 m	12%	100%
extSZ004	0.001 m	12%	100%
extSZ002			
extSZ001	0.001 m	63%	100%
extSZ003	0.001 m	15%	100%
extSZ004	0.001 m	16%	100%
extSZ003			
extSZ001	0.001 m	12%	100%
extSZ002	0.001 m	15%	100%
extSZ004	0.000 m	83%	100%
extSZ004			
extSZ001	0.001 m	12%	100%
extSZ002	0.001 m	16%	100%
extSZ003	0.000 m	83%	100%

Overall Cloud-to-Cloud Error: 0.001 m | Save as RTF | Close | Help

Fig. 3 Quality control for target-less registration - outdoor scans

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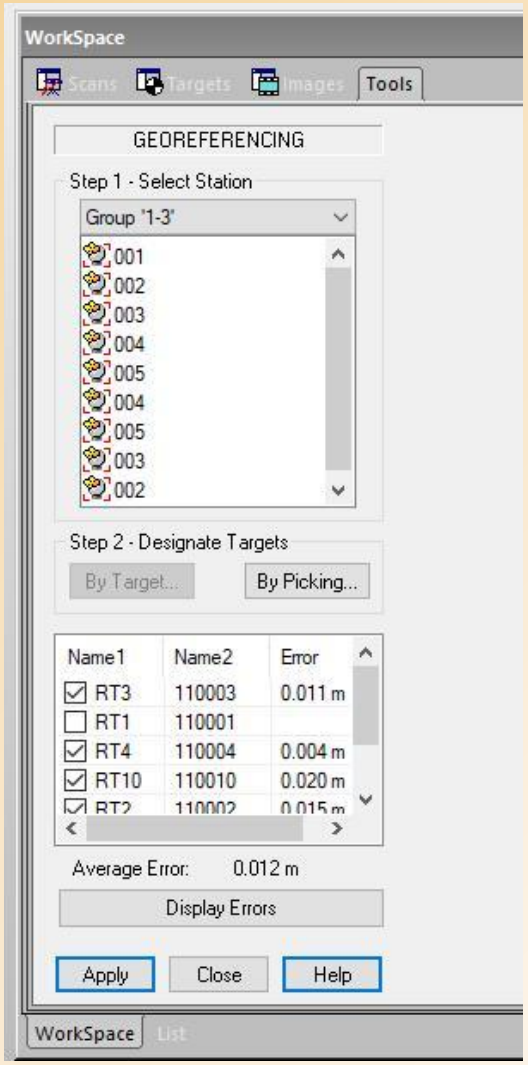

Fig. 4 Georeferencing of the point cloud and results from the quality assessment

9. Analysis of the results

The numerical results, given in chapter 8 show very high quality of the processed raw data:

a) **0 mm overall residual error** from the registration of four stations in the interior of the building – fig. 2;

b) **1 mm overall residual error** in the registration results for exterior stations, derived from three stations of the scanner – fig. 1;

c) **1 mm overall cloud-to-cloud error** - calculated from data, measured from four stations of the instrument. It should be noted that the information was processed with 100 % confidence for every station - fig. 3;

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9. Analysis of the results

d) the final processing of the point cloud – its georeferencing was calculated with 12 mm average error, fig. 4.

The value of the average error from georeferencing met the accuracy requirements of both fields of activities in this paper – cadastral and design.

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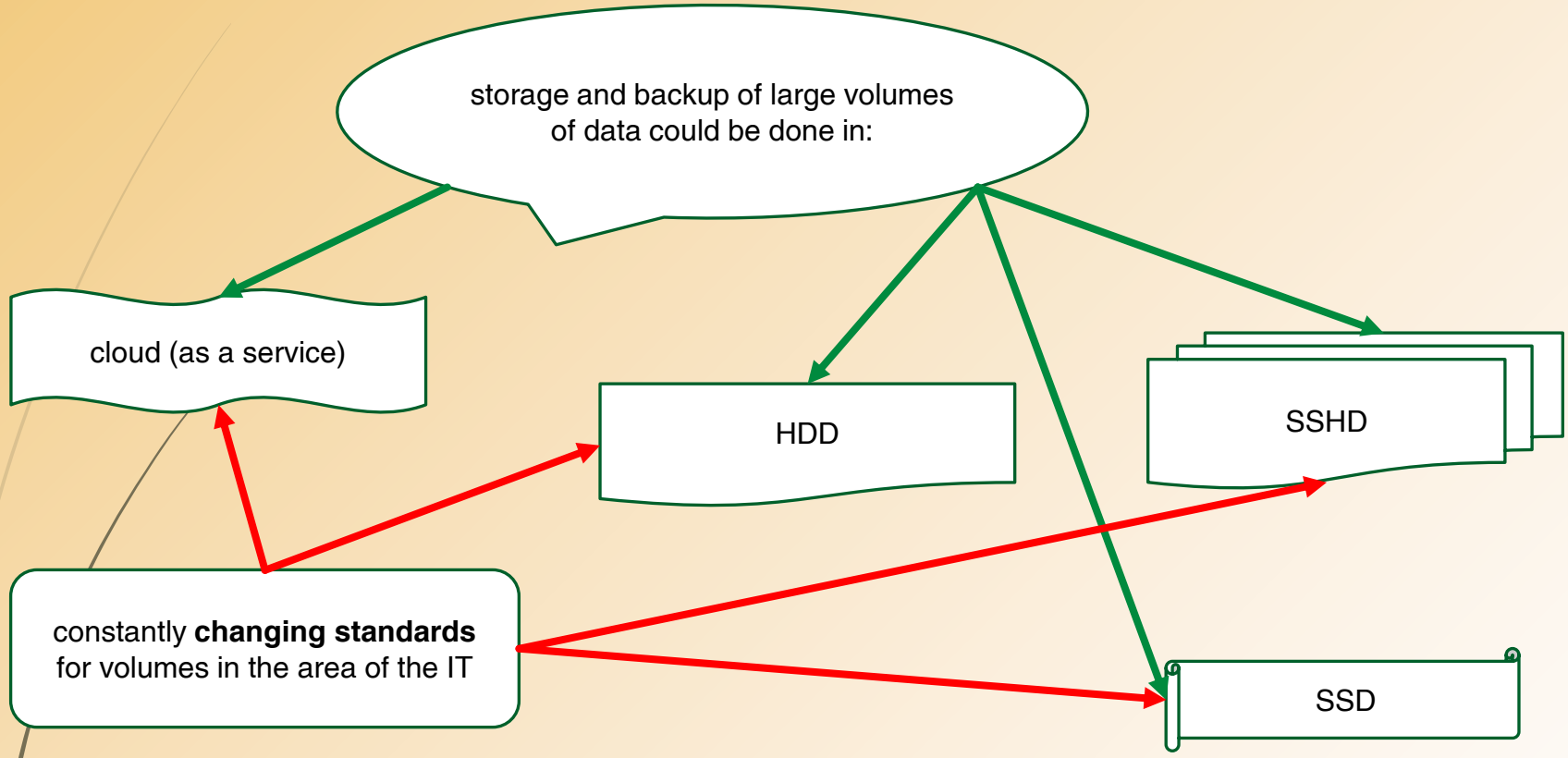
10. Cloud storage and backup both of the raw data and processed information



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10. Cloud storage and backup both of the raw data and processed information

working with gigabytes

the selection of **appropriate cloud storage** provider should be done very carefully

Key moments to be taken into account

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-**file formats** of the information from 3D terrestrial laser scanning data;

-the **attributes** of the files of the raw data;

-the **volume** of the data.

10. Cloud storage and backup both of the raw data and processed information

IDrive, Mega and pCloud - used in this study
as “Best cloud storage of 2020”

Raw data and processed laser scanning project were **stored in the cloud**.

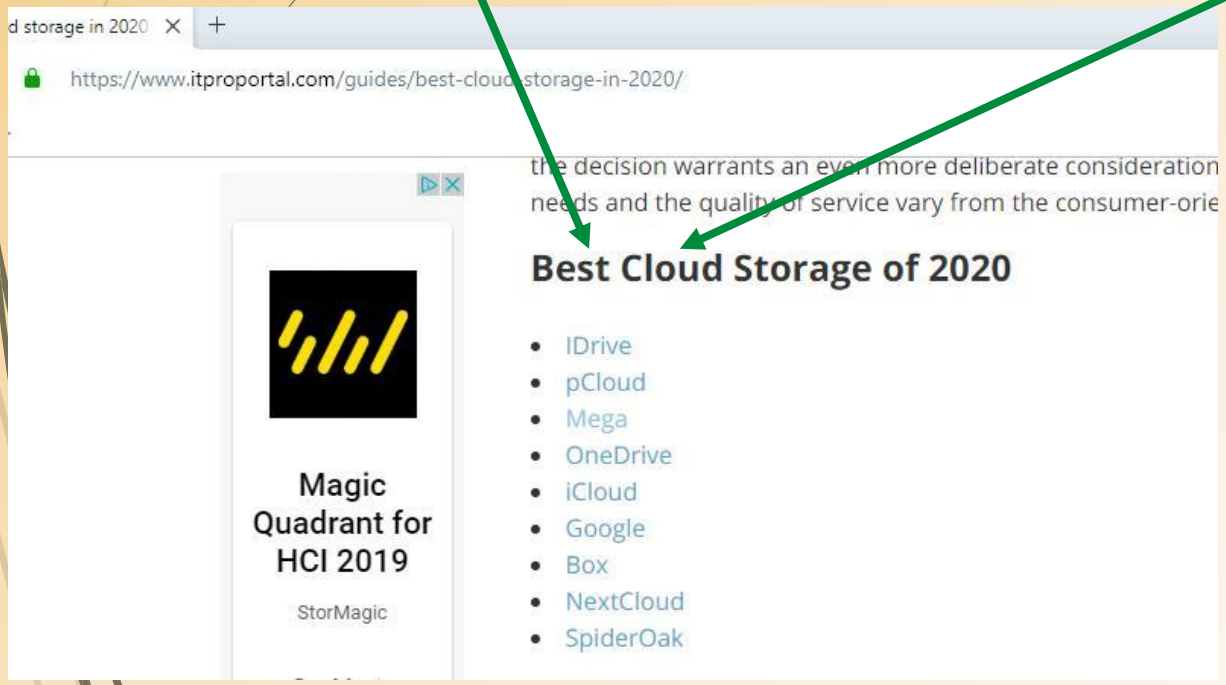

Fig. 5 Best cloud storage providers for 2020

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10. Cloud storage and backup both of the raw data and processed information

issues were encountered

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a) for IDrive:

–after upload of the raw data *.fls file was **missing** in the cloud;

-two step verification was **required**;

-sharing of the information **requires** the recipient to be IDrive user.

10. Cloud storage and backup both of the raw data and processed information

issues were encountered

b) for Mega
–in the raw data, after upload was **missing** the file with ".classid" extension,

-transfers of the information with **slow/unstable** speed were observed.

issues - eliminated

if the information was stored in *.zip, there were **no issues**.

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11. Conclusion. Recommendations

This paper studied the application of 3D terrestrial laser scanning in the fields of cadastre and design, in the light of **contemporary possibilities of the IT**.

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In chapter 10 were listed the practical issues, which encountered in the process of online storage and backup of laser scanning data.

11. Conclusion. Recommendations

3D terrestrial laser scanning was used as technology, which eliminated any possibilities for human errors.

The IT involved in this case was a look ahead to a union of two **innovative technologies**:

-3D terrestrial laser scanning;
-online storage of both raw and processed data.

11. Conclusion. Recommendations

The results below show the accuracy of the processed laser scanning data:

a) **overall residual error** for the target-based registration – **1 mm**;

b) **average error** for the georeferencing - **12 mm**.

The **combined** usage of the modern technologies:

a) in the area of **surveying** – 3D terrestrial laser scanning;
b) in the area of **IT** - cloud storage services,

led to one **contemporary and refined model** for geodetic activities in the areas of cadastre and design.

12. Outlook

Future work. It should be noted, that obviously the technical side of the services of the cloud storage providers should be improved in the means of fixing the issues with specific laser scanner data formats and their handling in the cloud.

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DESKTOP APPS

Mega Desktop App;

pCloud Drive;

Trimble RealWorks.

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Thank you for your attention!

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