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Combining of Scene Measurements by Laser Scanner and GPS Combination




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Combining of Scene Measurements by Laser Scanner and GPS Combination

Outline

1. Introduction
2. The georeferencing methods of laser scanning data
3. TLS-GPS sensor combination
4. Conclusion and Future work



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INTRODUCTION

- The TLS is the survey instrument which has the ability of rapidly collecting a high resolution 3D (x,y,z) and intensity data from an object or a scene.
- Laser scanning data is the point cloud in the local cartesian coordinates, centre of which is the instrument.
- all scans are registered relation to coordinate system of the scan that was selected as a reference (Pfeifer and Briese, 2007).
 - range data (Besl and McKay 1992; Chen and Medioni 1992; Gruen and Akca, 2005)
 - integrated camera image (Al-manasir and Fraser, 2006, Altuntas, 2010)
 - range and image data (Dold and Brenner, 2006)

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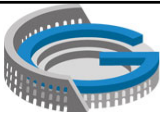




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Introduction

- If the scan was performed according to common coordinate system, all spatial data from the TLS, photogrammetry, theodolite and GPS can be related without any extra measurement.
- The **georeferencing system** is the most suitable coordinate system to combine TLS point clouds.


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Introduction

- The georeferencing is highly recommended for both registration of the laser scanner data, and integration of them with the topographic and photogrammetric measurements (Scaioni, 2005).
- The georeferencing is also an easy and fast method to supply spatial data for local based GIS such as Google Earth.
- For example, documents of cultural heritage can be exhibited in virtual museums located on GIS.
- Everyone can be access the information about the real world objects via the internet.

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Introduction

- **The georeferencing coordinate system**
National coordinate system
International coordinate system
Global WGS84 or ITRF coordinate system
- The registration from one to the other is possible in anytime.

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THE GEOREFERENCING METHODS

- The georeferencing methods of TLS point clouds can be classified (Yildiz and Altuntas, 2009)
 - Independent model triangulation,
 - 3D similarity registration,
 - Direct georeferencing.

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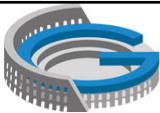




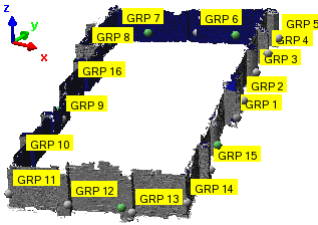
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The georeferencing methods

- Independent model triangulation (Scaioni, 2003; Elkhachy and Neimeier, 2006)
 - The relationship between all the overlapping laser scanner data is established by at least three tie points. Absolute orientation of the model coordinates according to the extensive reference frame is performed by at least three ground reference point (GCP)s, which is defined in the extensive system on the whole model surface.



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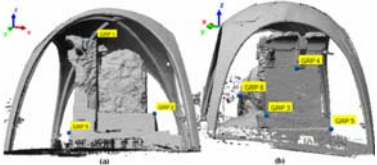
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The georeferencing methods

- **3D similarity registration:** It is applied separately or together to the point clouds.
 - In the first, all of the scans of the same object are registered into the references frame by at least three GCPs to the each one.
 - In the second technique, all of the scans of the object is registered with any methods. Then 3D model of the object is registered into the references frame system with at least three GCPs selected on the whole object.



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The georeferencing methods

- **Direct georeferencing**
 - TLS and theodolite (Scaioni, 2005)
 - TLS and compass (Schuhmacher and Böhm, 2005)
 - **TLS and GPS combination** (Waggot *et al.*, 2005)

Mobile laser scanning, which has GPS/IMU (Inertial measurement unit) combination, is also collect direct georeferencing data (Talaya *et al.*, 2004).




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TLS-GPS SENSOR COMBINATION

- The Topcon GPS receiver was mounted on Iris 3D laser scanner. The GPS receiver must be fixed to TLS and translations (t_x, t_y, t_z) must be computed between phase center of these sensors. Since the rotation parameters will be changed on each station, they do not need to compute. The GPS receiver has to be mounted on the same position for every mounting to TLS, and the same parameters have to be used in each station. Hence, the apparatus was designed to fixed the GPS onto the TLS.



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TLS-GPS sensor combination

- GPS and target shape were combined with special design. The dimensions of the target shape were created according to the average measurement distance, and the GPS was fixed on it as the center of them on the same vertical line.



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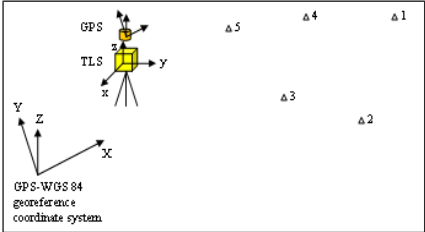
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TLS-GPS sensor combination

- To computation of translation parameters, the GPS was mounted on the TLS, and other GPS on the target shape was located scan field. The laser scanning was performed, and then the GPS on the target was removed to different location on the scan field. The laser scanning was repeated for five GCPs on the scan field without moving the TLS.





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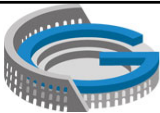




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TLS-GPS sensor combination

- Translation parameters (t_x, t_y, t_z) between TLS and GPS coordinate systems are computed with TLS and GPS coordinates of GCPs

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{GPS} = \lambda \cdot R_{\text{opk}} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{TLS} + \begin{bmatrix} X_o \\ Y_o \\ Z_o \end{bmatrix}$$

- $[X_o, Y_o, Z_o]^T$ and R_{opk} are translations and rotations respectively between GPS and TLS coordinate systems, and
- λ is scale,
- $[X \ Y \ Z]^T_{GPS\text{receiver}}$ is GPS coordinate of the GPS receiver on the TLS, and
- $[t_x \ t_y \ t_z]^T$ is translations between TLS and GPS receiver

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TLS-GPS sensor combination

	#GCP	t_x (m)	t_y (m)	t_z (m)	σ_x (m)	σ_y (m)	σ_z (m)
First measurement	5	-0.1365	-0.1118	-0.1285	0.0780	0.0727	0.0756
Second measurement	6	-0.1419	-0.0593	-0.1038	0.0180	0.0167	0.0176

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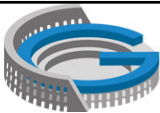




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TLS-GPS sensor combination

- The translation parameters can be used for low accuracy applications such as open mining and geological measurements.
- However, the parameters have to be estimated with high accuracy for urban and architectural measurements. The accuracy of the parameters depend accuracy of laser scanner coordinates of the GCPs. The TLS coordinates of GCPs are extracted from point clouds. If the GCP is long distance away from the TLS, point cloud coordinates can not be extracted with accuracies. The GCP on the scan field must not be located long distance away from the scanner for more accuracy.

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CONCLUSION AND FUTURE WORK

- The georeferencing of laser scanner point clouds is important to combine them with other spatial data. In this study, TLS-GPS combination was executed to laser scanning based on georeferencing system. The GPS receiver was mounted on the Ilris 3D laser scanner, and translation parameters between of them were estimated. The estimated parameters can be used only for low accuracy applications. In further study, the parameters will be estimated with high accuracy and laser scans will be performed by TLS-GPS combination.

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- Thank you for your attention

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