

Three Dimensional Mapping Using Terrestrial Laser Scanning "TLS"

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ABSTRACT

In this paper, an overview of Terrestrial Laser Scanning "TLS" will be given. Details on how a scanner is used to collect data will be explained, and example applications will be described. There have been a number of issues when using laser scanning, and these will be explained, and the reasons for the issues give. The paper will end with recommendations and conclusions given. A laser scanner automatically determines 3D coordinates of points, by it rotating horizontally and vertically measuring the distance to objects and the angle. The coordinates can then be determined for every point with an accuracy of a few mms. The range of a laser scanner can be from about 100 m to a few kilometres depending upon the instrument. The grid size (resolution) can be set by user, and the colour image is captured by an integrated digital camera. The paper outlines many applications of laser scanning, including a retaining wall displacement test. Two point clouds differing in time are created, and software to difference the point clouds is then used. One of the largest issues is the size of the datasets. Work in Greece created data sets with billions of points, with each point having seven attributes, these attributes being x,y,z, red green and blue vales for the colour image, and an intensity value. The paper show that terrestrial laser scanning is a very versatile technique, although expensive, usually costing over \$70000 Canadian dollars. The scanner can produce a spatially accurate digital model and also a permanent digital record of the scanned site. However, the challenge is often dealing with massively large datasets (consisting of billions of points), causing processing and managing of the data to be a real issue.

Keywords: TLS; point cloud; 3D; BIM.

1. INTRODUCTION

- Overview of Terrestrial Laser Scanning
- How used to collect data
- Example applications
- Issues encountered
- Recommendations and conclusions

2. METHODOLOGY

The changing tides of technology:

- Theodolite and catenary taping
- Theodolite and EDM
- Electronic theodolite and EDM
- Total Station (EDM requiring reflectors)
- Total Station (reflectorless EDM)
- Laser scanner (automated Total Station with reflectorless EDM)

3. RESULTS AND DISCUSSION

The paper outlines many applications of laser scanning, including a retaining wall displacement test. Two point clouds differing in time are created, and software to difference the point clouds is then used. One of the largest issues is the size of the datasets. Work in Greece created data sets with billions of points, with each point having seven attributes, these attributes being x,y,z, red green and blue vales for the colour image, and an intensity value

3.1. Laser scanner operation

- Automatically determines 3D coordinates of points
- Scanner rotates horizontally and vertically measuring distance to target (from REDM) and angle
- Coordinates determined for every point
- Accuracy of a few mms
- Range: about 100 m – a few kms.

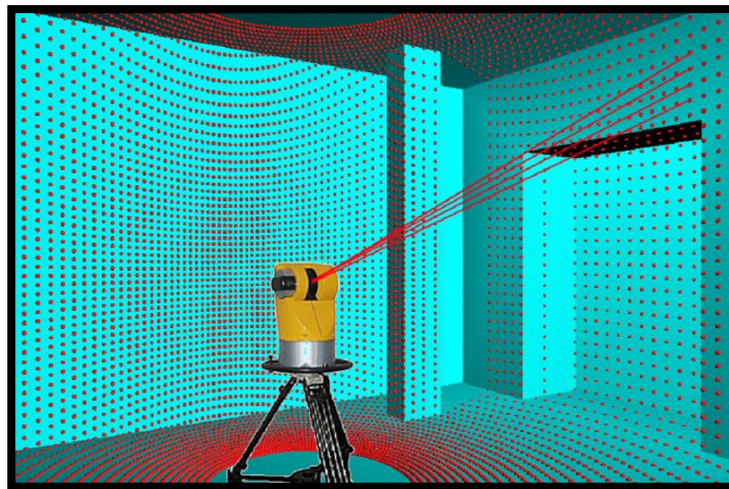


Figure 1. TLS in operation.

3.2. Applications of TLS technology. Study cases.

- Scan from one setup produces “point cloud” – thousands, often millions, of points with 3D coordinates, and Red-Green-Blue values from camera. Shadow areas.
- Some scanners also measure signal return intensity
- Scan of entire subject often requires more than one setup.
- “Register” scans using common points.
- Connect to coordinate system – GPS in scanner; coordinate setup point; scan points already in coordinate system.



Figure 2. Technology available (Trimble TX5 or Faro Focus 3D).

3.3. Main results

Building Information Modelling (BIM):

- Highly detailed measured building survey
- For renovation, restoration or retrofit projects.
- Software (e.g., AutoDesk “Revit”) used for to convert pointcloud to a model
- Deconstruct a building into individual elements [existing building]
- Model and map building elements and utilities during construction
- Adding metadata to model from pointcloud adds value to model.

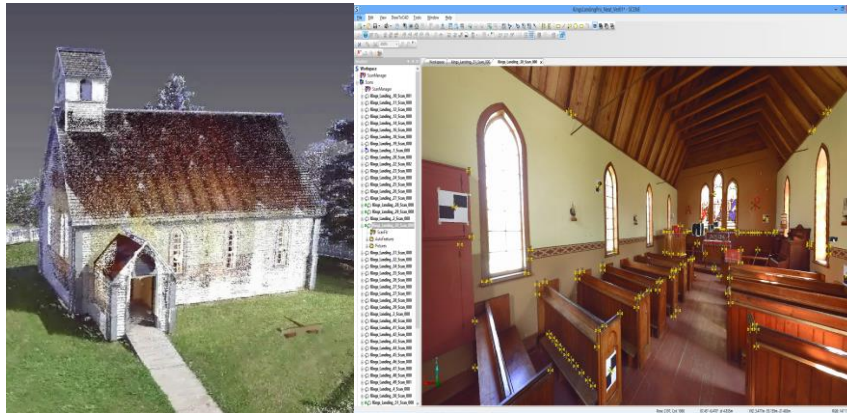


Figure 3. Chapel at King's Landing



Figure 4. Car Accident Investigation with Fredericton Police Force



Figure 5. Archaeological site at Kalymnos

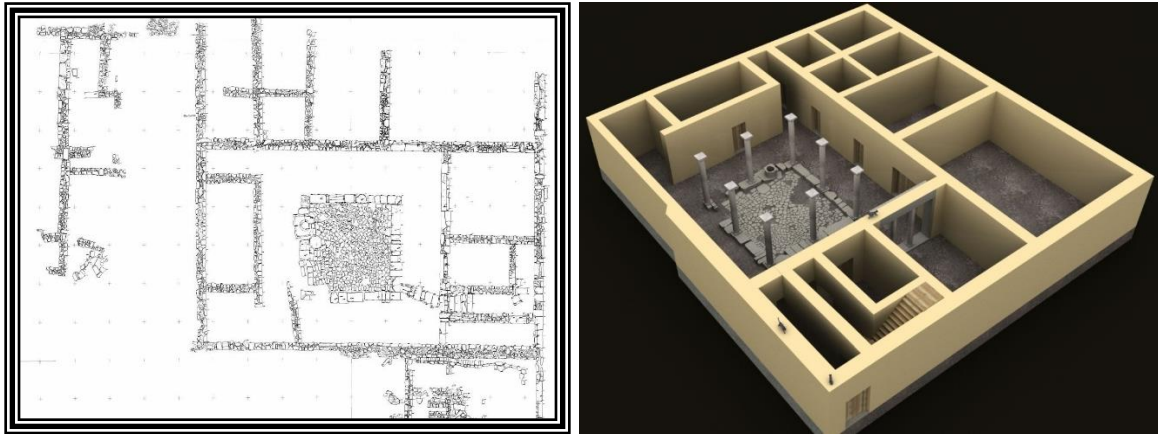


Figure 6. Archaeological site Abdera, Greece

4. CONCLUSIONS

- Terrestrial laser scanning (TLS) is a very versatile technique
- Expensive – over \$70000 Canadian dollars
- Creates spatially accurate digital models
- Permanent digital record of site
- Massively large datasets (billions of points)
- Processing and managing data becomes a real issue.

5. CONFLICTS OF INTEREST

The authors do not declare conflicts of interest

6. BIBLIOGRAPHIC REFERENCES

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ABOUT THE AUTHORS

Peter Dare joined the University of New Brunswick (UNB), professor of Department of Geodesy and Geomatics Engineering in August 2000. Dr. Dare is a member of a number of worldwide professional institutions and committees. Since joining UNB, Dr. Dare has spent some time with a major international project at a World Heritage Site in Turkmenistan. His role was to create a base map through a combination of GPS and space imagery.

Maria Papaioannou, professor Department of Classics and Ancient History of the University of the New Brunswick, she has participated in different national and international projects related to the historical, cultural and patrimonial value of buildings.