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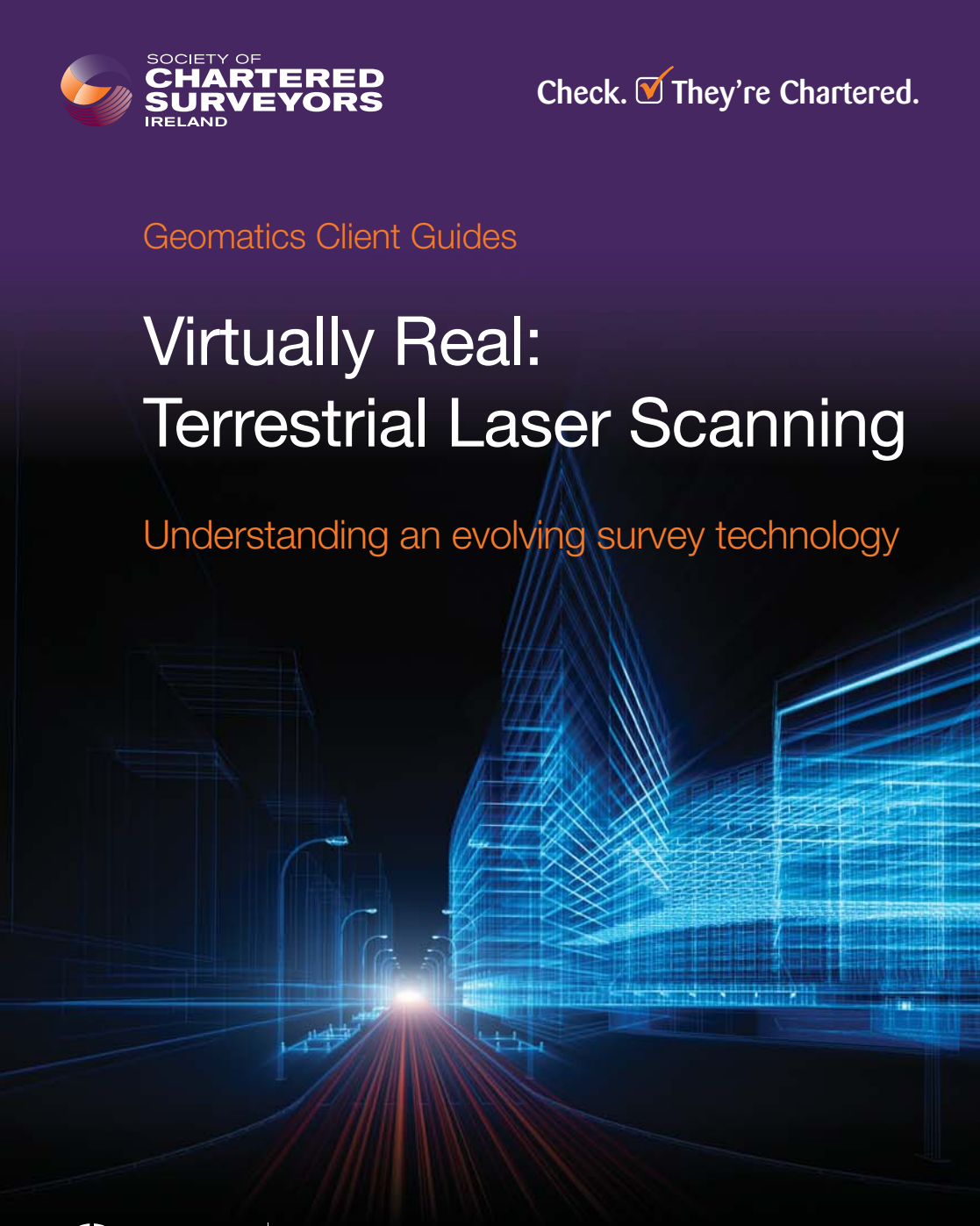
Geomatics Client Guides

Virtually Real: Terrestrial Laser Scanning

Understanding an evolving survey technology



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Summary

This guide gives you an overview of the technique, some of the benefits and limitations of its use, and where to go for further advice.

What is terrestrial laser scanning?

Laser scanners measure three-dimensional coordinates across an object's surface automatically, in a systematic manner, at high speed and in near-real time using laser range finding.

Scanning is usually used to measure surfaces and record spatial relationships, but discrete lines, facets and other geometric features can also be extracted from the data using appropriate software. Scanners rely on having line of sight from the instrument to the object, but scans can be performed from multiple positions and combined to record a subject more comprehensively.

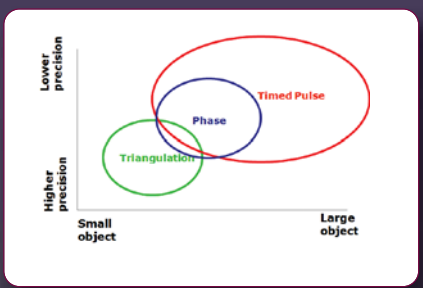
Laser scanners can work in conditions where lighting is poor and other surveys would not be practical, although appropriate lighting may affect results obtained from particular instruments.

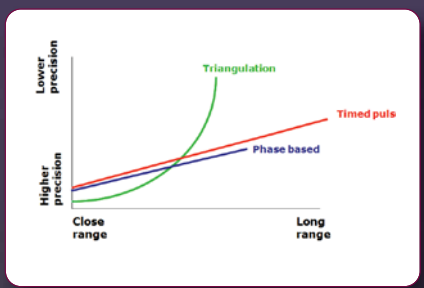
The accuracy and effectiveness of laser scanning techniques (both from the air and from the ground) are now well established. There are two broad approaches to terrestrial laser scanning: mobile and static, with many different types of system being used in both approaches.

For mobile scanning, one or more laser scanners are mounted on a vehicle and, by integrating the observations with position and orientation information from other sensors, they scan as the vehicle moves. In the static approach, which is the main focus of this client guide, the scanner is typically mounted on a tripod, like a conventional surveying instrument.

Static scanning instruments are available in a variety of formats and generally operate using one of three possible range finding principles across four distinct range categories:

- Close range, typically up to a few metres, with sub-millimetre precision. These instruments are usually “optical triangulation” scanners that are used to model small objects or artefacts in a laboratory.
- Short range, up to 50-100 m, with several mm precision. Such instruments typically adopt a “phase difference” approach to range finding.
- Medium range instruments use the "timed pulse" principle for range finding between 2 and several hundred metres, with a precision in the order of 5 mm.
- Long range, up to approximately 2 km, with a precision in the order of centimetres. Medium and long range scanners generally operate using the “timed pulse” principle.





Each category of instrument has distinct and differing technical characteristics, so a surveyor needs to select the most appropriate device to optimise a survey.

Scanning is often conducted in conjunction with other survey methods. In many cases, for example, best practice involves controlling the scans using data from conventional survey instruments. Scan data can also be augmented using image based techniques such as photogrammetry. Moreover, scanners often incorporate a digital camera that can be used to assign colour values to each scanned point for photo realism.

Terrestrial laser scanning benefits

This technique gives you a dense set of three dimensional coordinates, often referred to as a point cloud. Whilst data collection is very rapid, post-processing point clouds involves specialist and time consuming procedures, depending on the level of modelling required. Point cloud data can be used for:

- Producing as-built CAD models;
- Modelling objects and scenes for 3D visualisation, computer games and movies;
- Calculating areas and volumes;
- Generating a conventional 3D vector survey;
- Creating animations to help with spatial awareness;
- Data collection in environments where access is difficult or health and safety limits personnel entry.

When commissioning a terrestrial laser scanning survey consider:

- The survey cost/benefit compared to traditional methods;
- The new or additional products and enhancements that scanning offers over traditional survey techniques;
- Normal survey best practice to ensure that scanning procedures meet the project's accuracy requirements;
- The density of scan data has to be compatible with the size of objects to be surveyed;
- Most scanning surveys will involve joining together a number of scans - the surveyor's proposal should state how this will be done and how the resulting model will be fitted to survey control;
- The methods available to provide independent quality assurance for the survey and resulting products;
- The significant additional computing resources needed for handling and manipulating a point cloud and derived three dimensional products efficiently. Although viewing software may be free of charge, there may be significant client-side software and training costs for manipulating and modelling point cloud data. It may be wise to conduct a pilot study in the first instance.

Make sure a detailed schedule of the products to be produced, and that any limitations on use, are noted on the quotation. Always confirm that the factors critical for your use will be met, obtain a full method statement and Health and Safety risk assessment (see IS-EN-60825) from the provider.

When using point clouds as a source of measured data be aware that:

- Terrestrial laser scanning does not allow you to select discrete features – their accurate identification within a point cloud relies on appropriate point sampling density and measurement precision;
- While a number of the points may be superfluous for a particular product, the large number of points found in a raw point cloud may be a valuable archive product;
- Procedures for checking data collected by laser scanning are not yet standardised;
- You need to be able to view the subject from all aspects when scanning in order to model it fully;
- Laser scanning is just one surveying technique. Other techniques, or a combination of approaches, may be more appropriate.

Further information available:
This client guide is one of a series from the SCSI Geomatics Committee, the full series and professional guidance can be downloaded from: www.scsi.ie

SOCIETY OF CHARTERED SURVEYORS IRELAND

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