WHITE PAPER

TRIMBLE® 3D SCANNING FOR SURVEYORS

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ABSTRACT

3D Scanning is a powerful technology that uses advanced laser measurement technology to obtain measurements at many thousands of points per second. Surveying professionals are eager to adopt this new technology due to the dramatic productivity benefits that can be obtained. However, the lack of versatility of scanners together with unfamiliar workflows has limited the widespread adoption of the technology.

This paper describes the differences between laser scanning and survey workflows and introduces the Trimble® GX™ 3D Scanner. The Trimble GX combines a portable and robust 3D scanner with commonly used survey workflows to provide a 3D scanning system specifically for surveyors. The survey workflows are described, highlighting that surveying professionals are able to easily incorporate 3D scanning into their business portfolio to obtain greater survey productivity.

INTRODUCTION

Trimble 3D scanners use time-of-flight measurement technology that is based upon the principle of sending out a laser pulse and observing the time taken to reflect from an object and return to the instrument. Advanced electronics are used to compute the range to the target. The distance range is combined with angle encoder measurements to provide the three-dimensional location of a point.

This type of technology is similar to the Direct Reflex technology used in the Trimble S6 and 5600 total stations. However, the difference between 3D scanners and Direct Reflex (DR) technology used in total stations is the speed of measurement. Total stations, such as the Trimble S6, can provide approximately 4 distances per second in DR mode. In contrast, the Trimble GX 3D scanner is capable of measuring up to 5000 distances per second!

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The ability to accurately position objects at over 1000 times the speed of a total station allows a 3D scanner to quickly produce large amounts of survey data. This data, commonly referred to as a "point cloud", can provide a three dimensional shape, or visualization, of the feature being measured.

For surveyors who are more familiar with measuring discrete points to identify a feature, the sheer amount of data that can be produced from a 3D laser scanner may seem overwhelming. However, a 3D scanner is still providing 3D positional information in a similar way to a total station. The main difference is that the speed of measurement allows a 3D scanner to provide more measurements in a shorter amount of time. This ability allows users to either significantly reduce survey field time or to collect a denser amount of points, which results in more accurate detail of the survey site.

In a similar way to early GPS technology, the first commercially available 3D scanners were generally used for specialized applications rather than typical survey tasks. As the technology has become more accessible and the benefits of such fast data acquisition have been realized, surveyors have started looking towards 3D scanners as a new tool for the future. As the interest by surveyors has grown, manufacturers have looked towards offering 3D scanning technology that is simple and efficient to use. However, without an integral survey focus few manufacturers have been able to offer a system that is truly designed for the surveying industry.

LASER SCANNING WORKFLOW

To understand the importance of a survey workflow with a 3D scanner it is necessary to first describe the workflow that has typically been used with a scanner up until today.

The traditional scanning methodology is to use measurements to a number of common targets or spheres to relate multiple scans together or to relate measurements to an existing control network.

This workflow involves placing the scanner at locations about the survey site and measuring to a number of targets (either flat or spherical), as well as the actual feature of interest (e.g. a building). The scanner is then moved to the second location and at least three common targets or spheres from the first scanner location are measured, see figure 1.

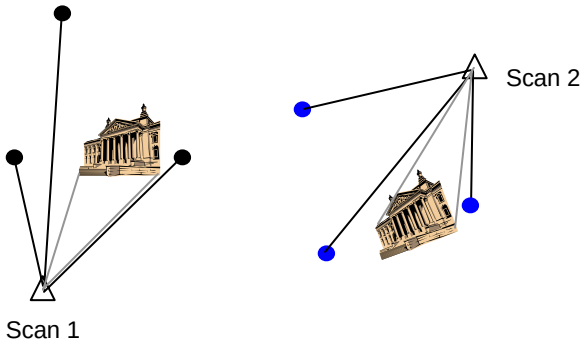

Figure 1: Multiple scans to common targets or spheres

The common measurements to the targets or spheres are then used to relate the scans together in a manner very similar to a GPS calibration workflow. This process is typically performed in the office once the field data collection has been completed, see figure 2.

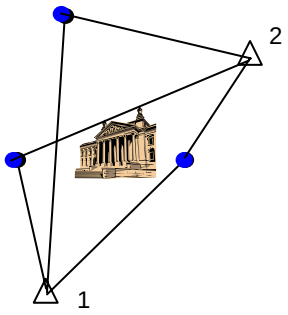

Figure 2: Relating multiple scans to common targets or spheres

While the scanning methodology is suitable for many applications, it does have limitations in that:

- the scanner cannot be easily set up over a known point or directly related to a known point;
- measurements have to be observed to multiple targets from each scan location, which requires careful survey planning and additional occupation time to measure each target or sphere;
- multiple scans require field postprocessing to relate the scanned data together into a single homogeneous data set and to relate the data to an existing control network.

These limitations can be efficiently resolved and indeed simplified by using a traditional total station survey workflow (see figure 3), whereby the user:

- accurately positions the instrument on a known ground point;
- accurately levels the instrument using a plate bubble or electronic level;
- measures an instrument height to relate the location of the instrument to the known ground coordinates;
- accurately positions a backsight (BS) target over a known ground point;
- measures a target height of the backsight to relate the target location to the ground coordinates;
- observes the backsight target to orientate the survey;
- observes an additional target (foresight) to easily relate data from multiple scans in the field.

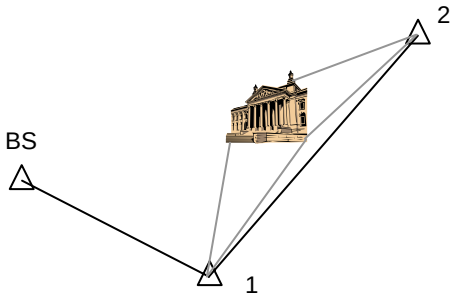

Figure 3: Traditional total station workflow

With the traditional total station workflow the scanner can be set up over known points thereby providing a direct relationship to existing ground control. Measurements between stations, commonly referred to as traverse measurements, provide an instant relationship between multiple stations and allow the user to view homogenous data in the field without additional post processing. The quality and extent of the survey data can be verified in the field, reducing survey time or costly re-measurement.

TRIMBLE GX SURVEY SOLUTION

To support the survey workflow, a modified approach to 3D scanning hardware, software and survey methodology is required. The Trimble GX is the first 3D scanner specifically designed for surveyors by surveyors. Survey operations and workflows have been built into the Trimble GX to provide a familiar, versatile and efficient tool for survey applications.

TRIMBLE GX HARDWARE

The first component of the 3D scanning system is the physical scanner itself, the Trimble GX.

Figure 4: Trimble GX 3D Scanner

Many 3D scanners are not well suited for survey applications as they are large, not easily maneuverable, or they require a ground power supply. In contrast, the Trimble GX is designed to be robust, portable and able to be operated with flexible power solutions. The scanner can be operated on either a ground power supply, a portable 24 V battery, or simply with two car batteries using a specific cable kit. The scanner can also be operated with a rugged field controller such as the Trimble Recon, thereby greatly enhancing the field portability. The entire system can be carried in a padded backpack, which increases the versatility of the system.

The Trimble GX supports a survey workflow via:

- A tribrach with laser plummet to ensure that the scanner is precisely positioned on a known point.
- A mark for accurately measuring the instrument height. The field software also corrects the

instrument height measurement for the slope to obtain a true vertical measurement.

- A dual-axis compensator for leveling the instrument over a known point. In addition, the dual-axis compensator actively corrects the horizontal and vertical angles for mislevelment to ensure that accurate measurements are obtained.
- A centric standard 5/8" thread mount in the top of the scanner. The thread allows a survey prism or GPS receiver to be placed on top of the scanner for positioning as part of an integrated survey solution, even during scanner operation.

In addition to these specific survey workflow features the Trimble GX is equipped with advanced laser technology that provides accurate focused measurements and enhanced long-range operation. This technology ensures that the scanner can be used for a variety of survey applications and environments.

TRIMBLE 3D SCANNING FIELD SOFTWARE

An integral part of a survey workflow is to be able to efficiently relate measurements between stations and known ground points. The Trimble GX scanner is offered with PointScape and PocketScape field software, which both support the survey workflow.

POCKETSCAPE

The PocketScape software is designed to operate on a rugged field controller, such as the Trimble Recon. While PocketScape fully supports a typical scanning workflow it also fully supports a survey workflow by providing familiar operation that is almost identical to that of a modern total station.

When a user first connects to the scanner and selects to start a station setup, an electronic level form is displayed, see figure 5.

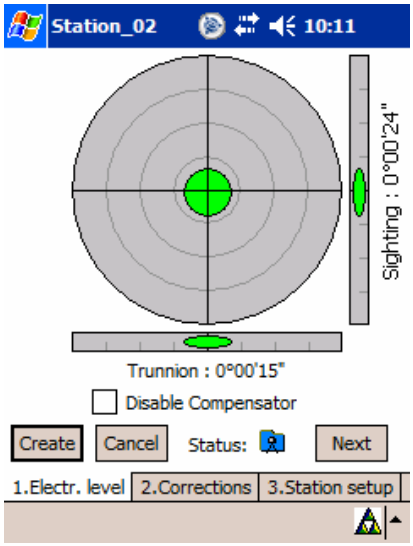

Figure 5: PocketScape electronic level

The electronic level enables the scanner to be fully leveled and positioned over a known point. Select *Next* and the user is able to enter atmospheric information to correct for refraction of the distance measurement, see figure 6.

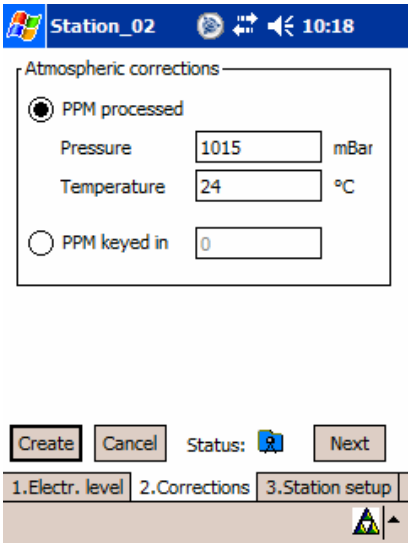

Figure 6: PocketScape atmospheric corrections

Select *Next* and the user is able to enter station setup information, such as the instrument point name and height, as a surveyor would during a total station survey, see figure 7:

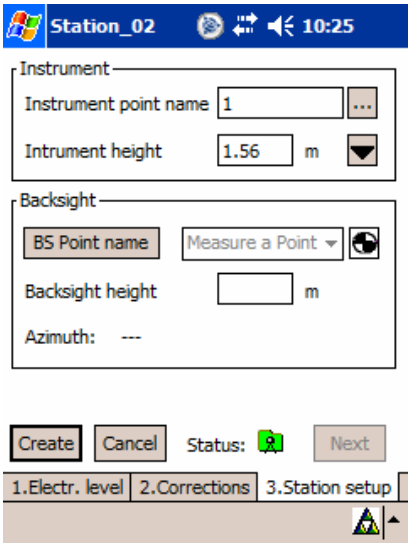

Figure 7: PocketScape station setup

Since the laser scanner does not have a telescope like a total station, it is necessary to scan the backsight target to accurately aim or define the backsight orientation. The button is used to scan a backsight point, target or sphere, typically in less than one minute. Once the target is measured you can assign a point name and backsight height to complete the backsight definition and orientation, see figure 8.

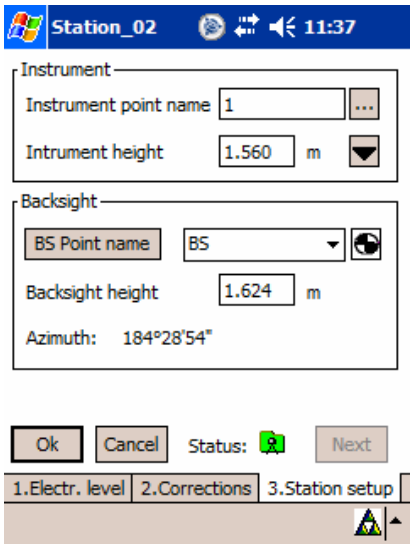

Figure 8: PocketScape station setup: backsight

The azimuth to the backsight is displayed for confirmation of the orientation. Select *Ok* to complete the station setup and then measure to additional targets or features from the fully referenced station setup. The wizard style approach and support for the survey workflow ensures that the surveying professional can easily operate the scanner.

POINTSCAPE

The PointScape software contains advanced scanning functionality and is designed to operate on a laptop PC. As with the PocketScape software, PointScape fully supports scanning and survey workflows. When the user connects to the scanner, PointScape automatically connects and displays the electronic level form, see figure 9.

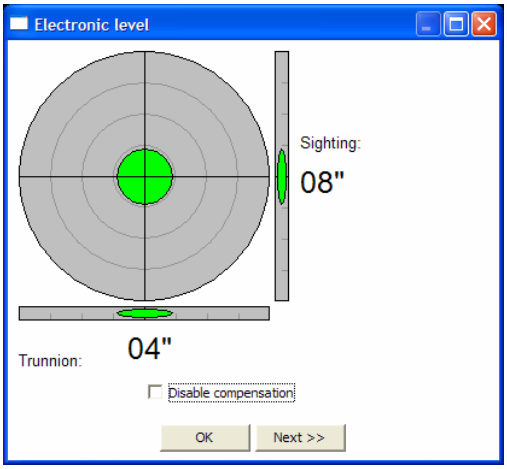

Figure 9: PointScape electronic level

The Trimble GX can be accurately leveled and positioned over the known point. Select *Next* and the user is able to enter atmospheric correction information as a surveyor typically would with a total station. Select *Edit / Add a Station* to display the station setup form, see figure 10.

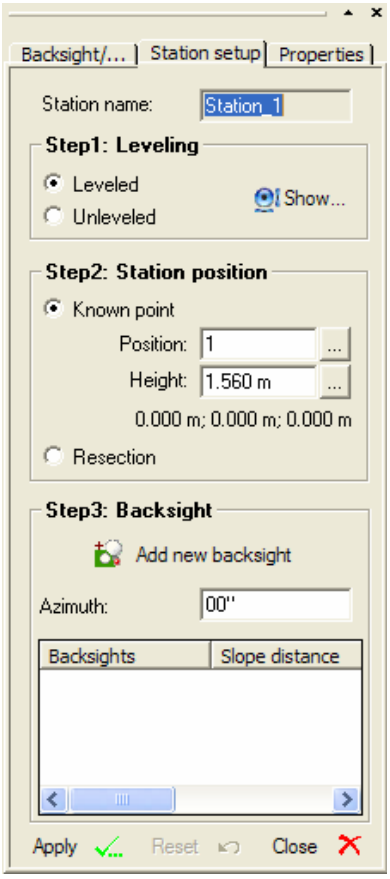

Figure 10: PointScape station setup

From the Station setup form the user can elect to perform a known point station setup or resection and enter the instrument point name and instrument height. The user can elect to measure a backsight point in the same way as a surveyor would during a total station survey. Once the station details have been defined the user needs to set the orientation of the survey. As with PocketScape, this process requires the user to scan the point, target or sphere at the backsight point to accurately define the orientation, see figure 11.

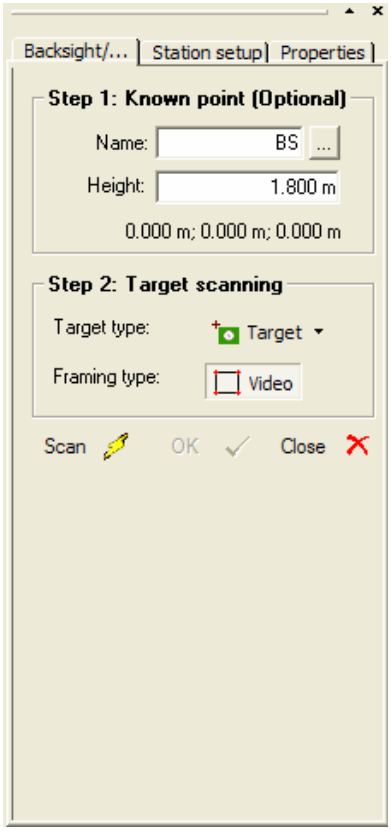

Figure 10: PointScape station setup: backsight

Once the backsight target has been scanned, select *Ok* to complete the station setup. Additional targets or features can then be easily measured from the fully referenced station setup. The structured survey workflow ensures that the surveying professional can easily operate and gain productivity benefits from the Trimble GX.

INTEGRATED SURVEYING SOLUTION

The Trimble GX easily complements GPS and total station techniques as part of an Integrated Surveying solution. For example, use traditional survey techniques to establish a control network of known ground points and then use the Trimble GX for efficient data collection over the survey site. Ensure maximum survey efficiency by having the right tools for each surveying job at your fingertips.

CONCLUSION

3D laser scanning is a powerful technology that offers many benefits to surveyors due to the increased speed of measurement. However, the lack of versatility of 3D laser scanners together with unfamiliar workflow processes has, until recently, limited a broad adoption of the technology by surveyors.

The portable and robust Trimble GX 3D scanner provides a typical survey workflow, so surveying professionals can quickly incorporate 3D scanning into their business portfolio. The short learning curve allows surveyors to increase productivity, create new business opportunities, and enjoy significant returns.

To learn more about how Trimble 3D Scanning solutions can help you and your business, please contact your local Trimble authorized distribution partner. Locate a dealer on our website at http://www.trimble.com/locator/sales.asp.