GEOLOCK TECHNOLOGY

White Paper | June 2013

Spectra Precision® GeoLock™ Technology

Abstract

GeoLock™ technology is a Spectra Precision® field software technique that allows a robotic total station to perform an aided search for an optical target using an initial GPS position. The technology greatly reduces the time to locate and lock onto a target.

This paper describes how GeoLock technology operates and how the technology is integrated with Spectra Precision robotic total stations to dramatically improve field performance and productivity.

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Introduction

For many years now, surveyors have embraced Global Positioning System (GPS) technology for surveying applications using survey-grade GPS receivers.
GPS has become universally accepted in the surveying industry allowing manufacturers to use GPS positioning technology to assist with conventional survey instrumentation, such as optical total stations. While some integration has focused on using survey-grade GPS receivers, only limited integration has been used with low-accuracy commercially available GPS receivers.

Spectra Precision has introduced an advancement in GPS technology applications that uses a low-cost, commercially available GPS receiver integrated with a robotic total station system. The Spectra Precision GeoLock technique combines a GPS position, supplied by the low-accuracy GPS receiver with the FOCUS® 30 robotic total station. The remote instrument can then be directed towards the robotic roving operator using the GPS position and a subsequent search is quickly performed to re-acquire the target at the robotic rover. This GPS-assisted technique, called GeoLock technology, is part of the Spectra Precision Survey Pro™ software. GeoLock technology provides a very efficient and effective method of acquiring the target on the robotic rover.

The following sections describe the principles of GeoLock technology and the method of operation within Spectra Precision Survey Pro software.

GeoLock hardware

GeoLock technology connects a low-cost navigation GPS receiver to the data collector, such as that integrated into the Spectra Precision Ranger™ 3 handheld that is operating a Spectra Precision FOCUS 30 robotic total station.

The Spectra Precision Survey Pro software on the data collector then receives and processes the data from the GPS receiver.

Many low-cost, commercially available GPS receivers can provide an unaugmented GPS position to an accuracy of 10 m, which is usually sufficient for basic navigation. For GeoLock technology, this accuracy is sufficient for turning the instrument to a location to begin searching.

A stream of GPS position data is provided from the receiver. When GeoLock technology is activated, the Spectra Precision Survey Pro software uses the GPS data stream to calibrate the GPS positions to the target positions generated by the robotic instrument.

GeoLock technology operates with many different types of GPS receivers[1]. When operating Spectra Precision Survey Pro software on the Spectra Precision Ranger 3 data collector, the recommended solution is the internal GPS receiver. This solution provides a highly integrated cable-free solution and the receiver is automatically configured by Spectra Precision Survey Pro for use with GeoLock technology.

If the data collector running Spectra Precision Survey Pro does not have an internally integrated GPS receiver, the GeoLock technique can be used with an external GPS receiver that can stream Navigation Marine Electronic Association (NMEA) positional strings.

[1] The receivers must support the NMEA data format.

Principle of GeoLock

GPS positions received via the NMEA data stream are referenced to the WGS-84 datum. Since conventional total stations are often operated on a local coordinate system or with an arbitrary orientation reference, it is necessary to relate the GPS positions to the total station setup. Spectra Precision Survey Pro software accomplishes this task efficiently and without user interaction.

When a total station measurement is observed to the robotic rover a corresponding GPS position is also observed. See Figure 1.

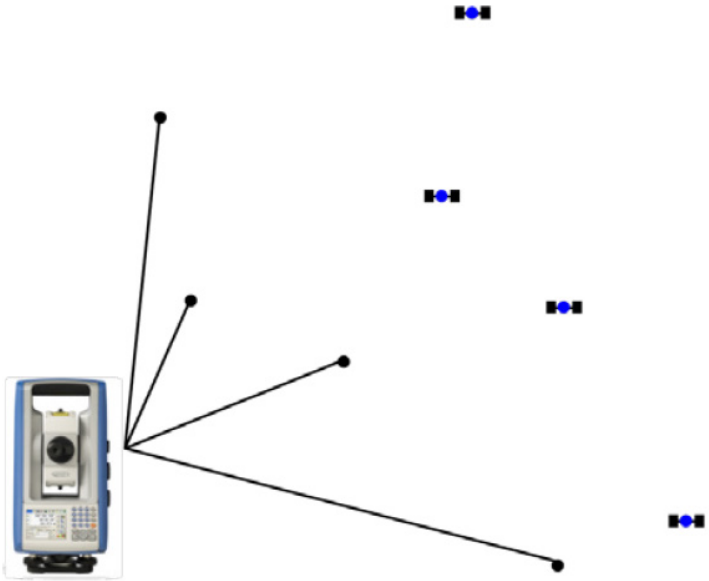

Figure 1: Collecting total station and GPS positions

The observations in both systems are then used to calculate a GPS calibration within Spectra Precision Survey Pro. The GPS calibration allows GPS positions to be transformed into the local total station system, as depicted in Figure 2.

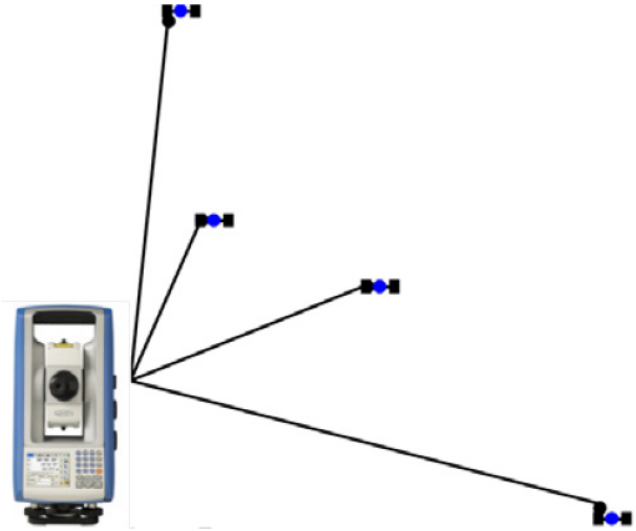

Figure 2: GPS positions calibrated to total station setup

The calibration is automatically calculated within Spectra Precision Survey Pro whenever the user is in robotic surveying operation. A minimum of seven measurements are required to calculate the calibration and enable GeoLock technology. These measurements can be quickly obtained by configuring the instrument to continuously return distances provided by the FOCUS 30 tracking mode. With this configuration the calibration is determined within approximately 10 seconds while the user walks through the survey area.

Improving the calibration

The calibration is initially calculated using a minimum number of GPS and total station measurements. Since these measurements may have been observed in close proximity or in one particular area of the survey site, it is necessary to continually monitor and improve the calibration. The continual improvement also allows any erroneous measurements to be discarded and therefore improves the performance and reliability of GeoLock solution. This is particularly important if the user has elected to use GeoLock technology for both horizontal and vertical components.

Several criteria are used when matching and filtering the GPS positions:

- The matching of points is performed by pairing a total station position to the GPS position observed at the same time. If there was no total station position at the exact time of the GPS position, then an interpolated total station measurement is obtained using the measurements before and after the GPS position. Matching the more accurate total station position to the less accurate GPS position allows GeoLock technology to only accept GPS positions that will not degrade the calibration.
- Positions obtained while the user is stationary are considered better than positions observed while moving. These positions are given precedence over moving points when determining if measurements are erroneous or not.
- A velocity filter determines the speed of movement between matched total station and GPS points. If the velocity exceeds a defined tolerance then the GPS position is discarded. This situation can occur when a satellite is lost, or the user walks underneath an overhead obstruction.
- The Dilution Of Precision (DOP) value for the GPS position is filtered to remove any GPS positions observed in a difficult sky-view environment, such as next to a building or in an area with potentially high multipath characteristics.

The continual use of the acceptance criteria ensures that the calibration is improved throughout the survey and that the performance and reliability of GeoLock technology is maintained.

GeoLock Operation

Since the complexities of GeoLock technology are automatically determined in Spectra Precision Survey Pro, the user interface is dramatically simplified for ease of use. To indicate GeoLock technology status, a simple icon appears in the title bar:

 Off (disabled)

 No GPS position or backsight defined

 Calibration being calculated

 GeoLock ready

When GeoLock technology is enabled and ready for use a GeoLock button is displayed in the remote control screen. The button is enabled in the following two instances:

- When the total station has lost lock to the target
- When the total station and GPS positions are distinctly different, or if one position is moving and the other position is not. That is, if the user has remotely turned to another target or the backsight point.

When the GeoLock button is selected the current GPS position is transformed to the total station system using the calibration parameters. The instrument is then turned to the GPS location and a search begins.

Automatically setting the search window size enables Spectra Precision Survey Pro software to minimize the search time required to re-acquire the target.

When used with the FOCUS 30 instrument, GeoLock technology typically re-acquires lock to the prism within 10 seconds of selecting the GeoLock button. This is a dramatic improvement over manually adjusting the

instruments pointing direction and then initiating a search.

In many instances, particularly at longer ranges, GeoLock technology re-acquires the target within 5 seconds, providing an exceptionally fast method of target re-acquisition. One of the key benefits of GeoLock technology over other target acquisition techniques is that it is not limited to range. GeoLock technology provides greater precision and extremely efficient control of Spectra Precision robotic total stations.

Conclusion

The integration of a low-cost GPS receiver with the robotic total station provides an impressive solution to greatly reduce the time taken to re-acquire a robotic target. The Spectra Precision Survey Pro software, operating on the Spectra Precision data collectors, uses this technology to provide GeoLock functionality to Spectra Precision FOCUS 30 robotic total station users. GeoLock technology enables users to quickly and accurately re-acquire the target at the robotic rover, which continually increases surveying productivity.