WHITE PAPER

# GEOLOCK™ TECHNOLOGY FOR THE PROFESSIONAL SURVEYOR

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## ABSTRACT

*GeoLock™ technology is a Trimble-patented 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 operates and how the technology is integrated with Trimble robotic total stations to dramatically improve field performance and productivity.*

## INTRODUCTION

For many years now, surveyors have embraced Global Positioning System (GPS) technology for surveying applications using survey-grade GPS receivers. And now, as GPS is becoming even more accepted in the surveying industry, manufacturers are using GPS 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 with low-accuracy, commercially available GPS receivers has occurred.

Recently Trimble, which has long been an industry leader in GPS technology applications, has introduced an advancement that uses low-cost, commercially available GPS integration with a robotic total station system. Using software developed in conjunction with Tripod Data Systems (TDS) and a patented Trimble technique, a GPS position can provide a robotic total

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station with an approximate position of the robotic rover. The instrument can then be directed to the GPS position and a search quickly performed to re-acquire the target at the robotic rover. This GPS-assisted technique, called GeoLock technology, is part of the TDS Survey Pro field software. Geolock 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 Survey Pro.

## GEOLOCK HARDWARE

GeoLock technology connects a low-cost navigation GPS receiver to the controller, such as the Trimble® TSC2™ Controller, that is operating a Trimble S6 or 5600 robotic total station. The Survey Pro field software on the controller 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, 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 is activated, the Survey Pro field software uses the GPS data stream to control the movement of the robotic total station.

GeoLock operates with many different types of GPS receivers[1]. GPS receivers with Bluetooth® technology can also provide a completely cable-free solution. When operating Survey Pro on the Trimble TSC2 or the Trimble Recon™ controller, the recommended solution is the low-cost CompactFlash GPS card receiver, such as the Trimble Recon GPS CF Card. This card provides a highly integrated cable-free solution and the receiver is automatically configured by Survey Pro for use with GeoLock.

## 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. 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.

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

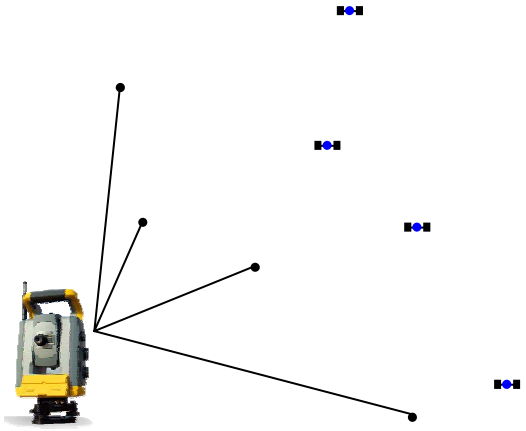

Fig. 1: Collecting total station and GPS positions

The observations in both systems are then used to calculate a GPS localization within Survey Pro. The GPS localization allows GPS positions to be transformed into the local total station system. See Figure 2.

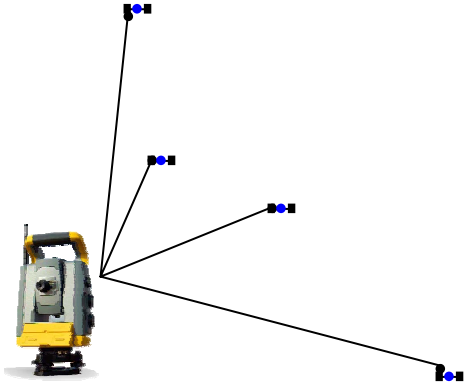

Fig. 2: GPS positions localized to total station setup

The localization is automatically calculated within Survey Pro whenever the user is in robotic surveying operation. A minimum of seven measurements are required to calculate the localization and enable GeoLock. These measurements can be quickly obtained by configuring the instrument to continuously return distances (i.e., TRK tracking or Continuous STD EDM modes). With this configuration the localization is determined within approximately 10 seconds while the user walks through the survey area.

## IMPROVING THE LOCALIZATION

The localization 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 localization. The continual improvement also allows erroneous measurements to be discarded and therefore improves the performance and reliability of GeoLock. This is important if the user has elected to use GeoLock for both horizontal and vertical components. Several criteria are used when matching and filtering the GPS positions:

1. 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 to only accept GPS positions that will not degrade the localization.

2. 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.

3. 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.

4. 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 localization is improved throughout the survey and that the performance and reliability of GeoLock is maintained.

## GEOLOCK OPERATION

Since the complexities of GeoLock technology are automatically determined in Survey Pro, the user interface is simple and easy to use. To indicate GeoLock status, a simple icon appears in the title bar:

 Off (disabled)

 No GPS position or backsight defined

 Localization being calculated

 GeoLock ready

When Geolock 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, i.e., 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 localization parameters. The instrument is then turned to the GPS location and a search begins. The size of the search window is automatically determined by the quality of the GPS solution. Automatically setting the search window size enables Survey Pro to minimize the search time required to re-acquire the target.

When used with the Trimble S6 instrument, GeoLock typically re-acquires lock to the prism within 10 seconds of selecting the GeoLock button. In many instances, particularly at longer ranges, GeoLock re-acquires the target within 5 seconds, providing an exceptionally fast method of target re-acquisition.

One of the key benefits of GeoLock over other target acquisition techniques is that it is not limited to range and will not result in the instrument locking onto any other targets in the survey area. GeoLock provides greater precision and extremely efficient control of Trimble 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 Survey Pro software uses this technology to provide GeoLock functionality to Trimble robotic total station users. GeoLock enables users to quickly and accurately re-acquire the target at the robotic rover, which continually increases surveying productivity.