Part 7: Receiver Installation

Practical Satellite Navigation

In the previous article on Practical satellite navigation installing the base was discussed. This is only part of a full installation. Just as important is the installation of the mobile station, or rover. There is a distinct difference between installation on mobile platforms such as construction equipment and installation for land survey or GIS use, which will both be discussed in this article.

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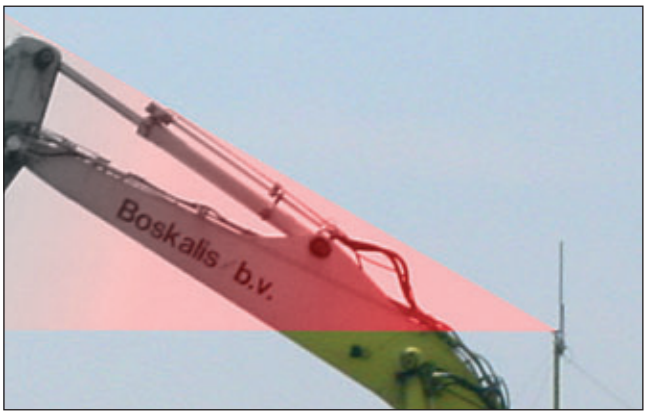

Figure 1: shielding caused by a backhoe boom.

Considerations

When installing a rover for static measurements, the same considerations for a base station, as mentioned in the previous article, apply. For an installation on a mobile platform such as a vessel, construction equipment or an aircraft, the antenna installation deserves extra attention.

As discussed in previous articles, the antenna needs a free view of the horizon. If this is not possible then there is the risk of shielding and multi-path which both will degrade accuracy of the position. If the antenna is installed next to another antenna or mast than a relatively large part of the horizon may be shielded, see figure 1. This problem is not particular to mobile installations, but with fixed installations it is usually easier to find an alternative location.

As a rule the antenna is located as high as possible since the chances of shielding are minimized this way. The risks involved are swaying and bending of the mast resulting in a degradation of the accuracy. When installing a system on or near metal platforms the risk of multi-path is considerably high, requiring the use of a ground plate or choke ring (see previous articles in GeoInformatics).

Radio Interference

As discussed with the base station installation, radio interference sources are posing a serious problem. When installing a base station it is simply a matter of relocating the antenna when interference is encountered. On a mobile platform this is easier said than done since there may be multiple sources such as communication-, telemetry- or radar systems causing interference. Furthermore a dGPS installation usually comprises two antennas that both need to be placed in a relatively small area. Another complication is the length of the signal cable. For regular GPS cables the maximum length is ten meters. After that the signal will be susceptible to noise. For longer distances higher quality cabling, which is thicker, less bendable and more expensive must be used. With these cables distances of 30 meters can be covered. This may seem much, but a mast length of 10 meters is no exception for small survey vessels (< 20 meters). When the distance between antenna and receiver is longer than 30 meters, special amplifiers with their own power supply must be used.

Multiple Antennas

On most mobile platforms more than one antenna is used. This is done, amongst others, to be able to locate the antenna as close to the other sensors as possible and to prevent shielding of a single antenna. By mounting a second antenna and a splitter box the user can easily alternate between the antennas without the use of an additional receiver. In some situations a single antenna is used which provides input to different receivers. This may be the case where both a code phase dGPS and a carrier phase dGPS system are used.

In these cases special attention should be given to the power supply of the GPS antenna. Almost all external antennas have a built-in signal amplifier which takes its power from the receiver. When using a simple splitter box the power supply to the antenna may be interrupted which will cause malfunctioning of the antenna.

Installation of a GPS antenna on a LIDAR helicopter (source: www.flimap.nl).

Installation on a survey vessel. The antenna is installed in the top of the mast.

Antenna Geometry

It should be clear by now that the installation of an antenna on a mobile platform is a matter of compromises. After installation, the position of the antenna with respect to the other sensors on the platform should be determined.

For land survey and GIS the antenna is usually placed on a survey rod. In this case the only offset that needs to be determined is the distance between the end of the rod and the phase centre of the antenna. This is usually done by applying a tape measure.

With installation on a mobile platform, determining the offsets is more complicated. The offset towards another sensor is a threedimensional problem, requiring more elaborate survey techniques derived from deformation measurements. Usually a local coordinate system is defined onto which all sensor locations are mapped. In some cases such as construction equipment even the coordinate system will be flexible. The antenna will for example be mounted on the cabin but its position output is then used to determine the position of the bucket at the end of a boom. Since most booms are constructed of several parts that can move independently from each other positioning becomes rather complicated. Measuring the joint angles between the sections and then using the length of the section to calculate the position of the bucket usually solves this problem.

Installation on a dredging vessel. A location on top of the cabin is chosen.

Receiver Settings

With the antenna installed, the base and rover receivers need to be configured for use. Important settings are:

- Geodetic reference system;
- Antenna height;
- Positioning method;
- Storage / telemetry;
- Elevation and satellite de-selection.

Geodetic Reference System

It is of utmost importance that the correct geodetic reference system is selected. With an incorrect setting the position can be off as much as hundreds of meters (see previous articles on Practical Satellite Navigation in this magazine).

Most receivers have the ability to cross-calculate between various geodetic systems and use the results for display, storage or transmission. Sometimes there is a difference between the displayed and stored / transmitted position. The default reference system for all GPS receivers is the World Geodetic System 1984 (WGS84). If additional software is used for storing sensor readings, then it is advised to perform all geodetic calculations in this software and leave the receiver in WGS84 thus minimizing calculation errors.

Using retro-reflection stickers on the rim of the antenna will ease the location determination with conventional land survey techniques.

Antenna Height

With most land survey and GIS systems the antenna height must be entered into the receiver. This height can be measured as a slant range from the end of the rod to the rim of the antenna or as vertical height between the ground and the antenna rim. Incorrect settings are usually hard to determine afterwards due to the relatively small errors involved.

Positioning Method

Most modern receivers offer the user a selection of positioning methods. Some receivers are capable of both code phase and carrier phase dGPS. But also switching on / off WAAS or EGNOS will influence the results. When using dGPS (with the exception of WAAS / EGNOS) the user needs to select a base station with the accompanying telemetry frequency. With some carrier phase systems the position of the base needs to be entered as well.

Storage / Telemetry

For survey systems the setting of storage or telemetry options is very important. Not only the exact data message, but also the frequency at which the data is stored / transmitted are important.

Most modern GPS receivers have the option to determine a position up to tens of times per second. However in most cases no actual position is determined but a prediction is made. This prediction is usually based upon previous position updates and is less precise than an actual measurement. The higher update rate will require more storage space or processor time. For most, non-mobile, applications an update rate of once per second is sufficient. For mobile applications the update rate depends on further use of the data.

De-selection

In order to obtain the best satellite configuration it is often wise to de-select some satellites. For example satellites with an elevation below 15° may be left out of the computation. Some receivers will have a setting for an elevation mask; others will automatically leave certain satellites out of the computation based on elevation and signal strength.

Sometimes a satellite is switched off for servicing. In these cases a notification will be sent to all users via the so-called Notices to Navstar Users (NANU). These can be found on the website of the American coastguard for example, see below. In such a situation the satellite will transmit a status indication stating that it is unusable.

In some cases the satellite is rendered unusable before a ground station can register this. In such a situation it can take several hours before the satellite transmits an 'unhealthy' status. In these cases the satellite needs to be de-selected manually on the receiver.

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