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GPS IN TOPOGRAPHY

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Abstract

Global positioning system (GPS) equipment, the world's best electronic distance measuring machines (EDMs), are becoming faster and easier to use. Not only does one use this new portable equipment to establish distance, but three-dimensional positioning is quickly available. The use of GPS as a tool for accomplishing boundary surveys; topographic surveys; location surveys; control surveys for GIS/LIS, photogrammetry, national, state and local coordinate systems; etc. The GPS locations can be performed by established methods, which may be presented as working solutions, depending on the situation on the field and the logistics you have endowed.

***Key words**: GPS, EDMs, surveys, topography, working solutions.*

INTRODUCTION

The aim of this paper is to present the purpose of the GPS (Global Positioning System) in topography.

Surveying or land surveying is the technique, profession, and science of determining the terrestrial or three-dimensional position of points and the distances and angles between them. A land surveying professional is called a land surveyor. These points are usually on the surface of the Earth, and they are often used to establish land maps and boundaries for ownership, locations like building corners or the surface location of subsurface features, or other purposes required by government or civil law, such as property sales.

Surveyors work with elements of geometry, trigonometry, regression analysis, physics, engineering, metrology, programming languages and the law. They use equipment like total stations, robotic total stations, GPS receivers,retroreflectors,3D scanners, radios, handheld tablets, digital levels, drones, GIS and surveying software.

Surveying has been an element in the development of the human environment since the beginning of recorded history. The planning and execution of most forms of construction require it. It is also used in transport, communications, mapping, and the definition of legal boundaries for land ownership. It is an important tool for research in many other scientific disciplines.

The Global Navigation Satellite System (GNSS) uses the technique of positioning objects that are moving or static, anytime, anywhere – whether they are on land, in air or under water.

Figure 1. Permanent GNSS Network – Romania

Starting in 1991 with the first GPS equipments and continued in 1999, when it was installed the first GPS permanent station in Romania (BUCU) at the Faculty of Geodesy – Technical University of Civil Engineering Bucharest in cooperation with Federal Agency for

Cartography and Geodesy Frankfurt (Germany), the new methods of global satellite positioning were introduced in Romania. Our country provides GNSS augmentation services under ROMPOS (Romanian Positioning Determination System) – Figure 1. ROMPOS is a part of the Central and East Europe ground station augmentation system named EUPOS – Figure 2.
ROMPOS services includes DGNSS service (dm accuracy), RTK service (cm accuracy) and GEO (geodetic service – cm/mm accuracy) DGNSS/RTK service can deliver augmentation data (corrections) based on single base or network concepts and the data are transmitted continuously by internet and NTRIP protocol – free of charge; GEO service is charged.

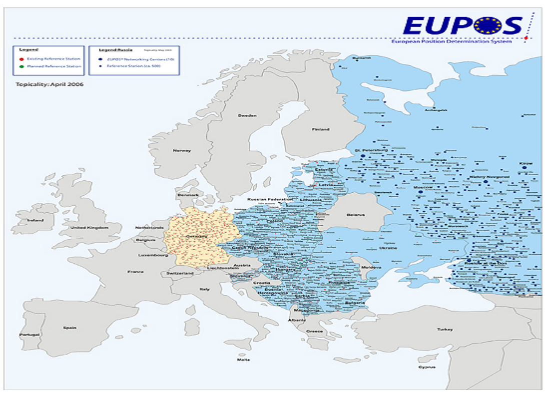

Figure 2. Permanent GNSS Network - Europe

MATERIALS AND METHODS

A Global Positioning System (GPS) is just a part of GNSS, used only for determining some points on the surface of Earth.
The GPS was first used for surveying in the 1980’s and the only way to obtain centimeter-level positioning was via post-processing. Users were required to place a base station receiver on a known monument and set it to record data – the same had to be done with the other receiver for lengthy period of time. After a couple of hours, both units were brought to the office in order to download the data and post-processed on a desktop computer.
In general, the GPS’s purpose is to provide the coordinates X, Y, Z of some points on the field, into the system that the user requires, stating from the basic ellipsoid of the 84 WGS system. The further progress of the GPS consists in automating the measurement work, which is used to cover the needs of surveyors at a rate of 100 % as regards the supporting network, 75 % for tracking, 75 % to the data acquisition of land in topographic surveys, etc.
The main target of the GPS is to provide the position, speed and synchronization (time) at any point on the surface of Earth, in relation to a reference system of the world (ellipsoid 84 WGS) and this 24/24 hours. In addition, the GPS should operate in all the climatic conditions and to accept an unlimited number of users.
The user can make GPS measurements if he has a compatible GPS receiver. There are many prestigious companies which produce such receivers which are very competitive. They allow you to make measurements on many satellites simultaneously.

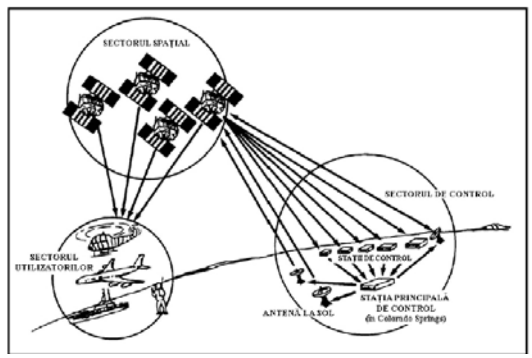

Figure 3. How the GPS works

In topography, GPS is used at the support networks of lifting equipment to the execution of longitudinal profile in cinematic mode, as well as finding out the coordinates of the detailed points. In addition, in the topography engineer, GPS is used in tracing in real-time and to the pursuit how the constructions (buildings, houses, etc.) behave in time.

There are two types of measurements:
a) Code measurements (pseudodistances) - which are used to find an absolute location-instant navigation type (meter accuracy precision)
b) Faze measurements – which allow obtaining the results of the relative location in differential mode (starting from a point known to an unknown point).

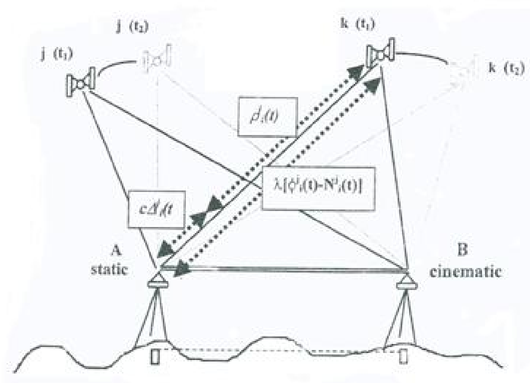

Figure 4. Static and Cinematic Mode

Regarding **the acquisition of data** there are two main ways:

a) Simple Static Mode – when the receivers are motionless on the ground for more than an hour. This mode gives the highest precision (+/- 1mm)

b) Fast Static Mode - normally used for receivers, with phase measuring and frequency, and leading to an accuracy of approximately 2cm. It takes less than the mode static simple, depending on the number of satellites that can be observed.

- baselines must be less than ten kilometers in length
- manufacturer's documentation should be consulted for determining the occupation period
- dual frequency receivers are preferred
- five or more satellites should be observed
- the recording rate may vary between five and fifteen seconds

c) Simple Cinematic Mode - uses the faze measurements and lead to the same accuracy as and faster static mode –stop and go system with two handsets: one on the known point and the other moving from one point to another in the field.

d) Cinematic Mode with Static Initialization- on the known points, in order to increase the accuracy of measurement.

After the manner of **data processing** there are two possibilities:

a) Post – Processed Kinematic (**PPK**)– the files must be recorded on each receiver, after which follows the data processing - the most accurate method of obtaining the coordinates of the points in the field.

- five or more satellites should be observed
- receivers should be initialized per the manufacturers recommendations
- each point should be occupied in a different session with different satellite geometry when measuring fixed points.
- the recording rate should be between one and five seconds Page 31 of 66
- single frequency receivers may be used although dual frequency receivers are preferred

b) Real Time –it does measurement and results at the same time, even in the field. The procedure can be used in order to determine an isolated point (with an accuracy of about 100m), in DGPS (with an accuracy of 1-5m), but the best is cinematic, when the mobile receivers are moving at a speed of approximately 40km/h and make a determination on every 3-5 seconds. So it is possible to obtain the coordinates at every 50m.

- Five or more satellites should be observed.
- Receiver specifications should be adhered to for consistent results.
- Each point should be occupied in a different session with different satellite geometry, unless collecting data while moving.
- The recording epoch rate should be either one or five seconds.
- Single frequency receivers may be used although dual frequency receivers are preferred.

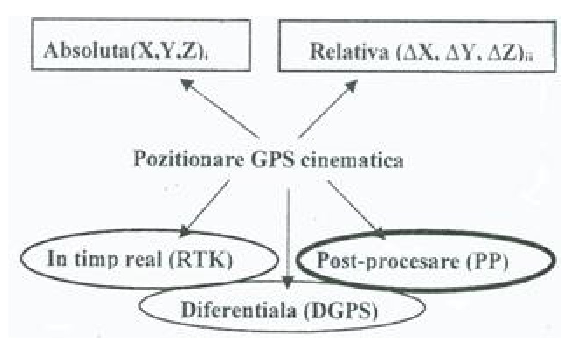

Figure 5. GPS cinematic position

In the early 1990's, **RTK** technology (*Real Time Kinematic*) was born and the GPS industry hasn't looked back. RTK allows the user to obtain centimenter-level positioning in real-time – that's the point when the GPS for staking became possible and the GPS for topo surveys became very efficient. RTK is the fundamental technology that makes machine control possible.

The basic concept behind RTK is that you have a base station receiver set on a known point somewhere around the project site. The base station receiver sends correction data to the surveyor who is operating the survey receiver. The correction data is typically sent via UHF or spread spectrum radios that are built specifically for wireless data transfer. The corrections from the base station receiver can be sent to an unlimited number of rovers.

Real-time positions on the rover receiver are calculated as fast a s 20 times per second. For staking and topo where the rod person will be carrying the range pole, once per second is plenty fast enough. In cases where RTK is used for machine control or topo surveys where the GPS is mounted on a four-wheeler or other vehicle and traveling at a good clip, faster data collection rates might be useful.

Topo surveys can be done very efficiently with RTK. One person can collect a tremendous amount of data in a day. The data collector can be set automatically take a shot every 25 feet or every 10 seconds or when there's an elevation change of more than five tenths. Otherwise, the operator has full control to name a point however they choose, and occupy the point as long as they choose.

Most systems RTK GPS, use the small radio modems on the frequency of the UHF.Radio communication is that part of the RTK system with which most users are struggling. Deserve to be taken into account the influence of the following factors at the time of the test to the optimization of the performance of the radio:

Figure 6.1. Data processing on a site (for two buildings) at PiataMuncii, Bucharest

Figure 6.2. Data processing on a site (for two buildings) at Piata Muncii, Bucharest

RESULTS AND DISCUSSIONS

Experience has shown that during a static GPS survey (using dual-frequency geodetic equipment), it is possible to get good loop closure and have very small residuals in the network adjustment, yet still have a large errors in the adjusted positions of some stations. This can happen if stations are occupied in one session only. In one situation, later traversing revealed an error of 2.4 meters in a station's coordinates that was occupied only once. Reprocessing the vectors in and out of the point, from a single session, changed the position by 2.4 meters to a position just a few hundredths different from one measured by ground traverse. Both the original and reprocessed GPS networks had good loop closure through the station in question. The vectors through the station in question had high variance numbers. There were compensating errors in the vectors in and out of the station. This can be attributed to the fact that both vectors into the station are computed from the same data set.

Figure 7. RTK GPS

CONCLUSIONS

The use of GPS equipment has the advantage that it does not require angular and distance measurements and the inconvenience of using total stations is also eliminated. At the same time, it is worth mentioning that with the RTK method (Real Time Kinematic) it is possible to determine coordinates with an accuracy that is comparable to that of the total stations and in a suitable period of time. One must also take into consideration the necessity to align Romania to the European and international standards by developing a GPS reference geodetic network of high-precision, whose points should be determined and included in the EUREF European GPS geodetic network

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