GPS AND GIS FROM THE USER PERSPECTIVE

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Abstract - The use of GPS equipment has provided increased positional accuracy during collection of GIS entity attribute information. This paper describes the GPS methods which are used at Denton County Electric Cooperative, Inc., (DCEC) along with test results of GPS data collection.

1.0 INTRODUCTION

The need for positional accuracy has long been a quest for many GIS users. This need may vary according to application, but the question has always been how to get "HIGH POSITIONAL ACCURACY" without incurring "HIGH COST". Our GIS database, which includes roads and land tracts is in a constant state of change. Updating our GIS database by the traditional means of aerial or total station surveys is effective but is expensive and the results are ephemeral in nature. With GPS you can keep up with this rapid change and put a cap on the "HIGH COST" of maintaining your GIS database. Code phase receivers are now available at a moderate cost and are able to provide positional accuracy of a few meters.

Several expedient and effective uses of GPS have been developed at DCEC. These uses include road update to U.S.G.S quads, exact subdivision location data for newly platted sub-developments and electric facilities inventory.

Currently DCEC is using the GeoLink mapping system which consists of both hardware and software. The GeoLink software works on a notebook computer and is a complete field mapping software program. This software program provides the user with position, navigation, satellite and other GPS information. The software also provides the user with a real time map display and shows current user position with a cursor which moves as the user travels. With GeoLink's F-Key scripting language a user can pre-program a data input interface with drop-down menus and pick list for rapid field data input. The GeoLink software links to Trimble Navigation's Pathfinder Basic code phase receiver via the computer serial communication port. Trimble's Community Base Station is used at DCEC's office for automatic collection of base files for differential correction of the GeoLink rover files.

GeoLink - Geo-Research Inc., Billings, MT
Trimble Navigation - Trimble Navigation Ltd., Sunnyvale, CA
2.0 GPS ACCURACY

Before using Code Phase GPS at DCEC we had to test its accuracy compared with Carrier phase GPS survey points. Figure 1 is a line diagram showing positional accuracy being achieved at DCEC using GPS. These test measurements were taken to provide DCEC a better understanding of GPS accuracy and to report this information to our Engineering Department. These test results were accumulated using static data collection and other GPS procedures consisting of:

1. Testing during optimum GPS conditions, availability of four or more satellites with PDOP less than six.

2. Collection of ten data sets each consisting of three minutes of GPS data recorded at one fix per second.

3. Calculation of the mean of each differentially corrected data set.

Note: All accuracy studies were conducted with reference to monuments surveyed at 1st order accuracy by static carrier phase GPS techniques.

![Graph](image)

Figure 1. Error distance between surveyed coordinate and test coordinate.

These positions were taken in a random manner and show typical GPS results. Test results indicate that about 90% are within 3-5 meters accuracy. This has assured the Engineering Department at DCEC that this GPS technique can be utilized successfully for our GIS update and maintenance needs.
3.0 ROAD UPDATES

The Achilles heel of many U.S.G.S. quads is that they are antiquated by over twenty years in most parts of the United States. GPS has now provided many cartographers a means of rectifying this deficiency and has given them the ability to post new road construction to the GIS database when needed. The following paragraphs describe procedures used by DCEC for updating roads:

I. City Street Updates.

Mapping city streets with the GeoLink system requires rudimentary computer skills; operators can be trained in three to four sessions. Mission planning is also done before each GPS survey to consider items such as satellite availability, pdop, traffic impediments, street starting and ending location, and other details before mapping begins. After mission planning is concluded the GPS operator would place the GPS unit and peripherals in the vehicle and the external antenna would be positioned on the right side of the vehicle roof. As mapping begins the operator should focus on driving his vehicle as close to the outer curb line as possible to map maximum pavement width. The operator may find parked cars along the route or other obstructions that must be avoided while mapping a street. This is permitted and will be edited out during the post processing procedure. After the GPS operator has mapped both sides of the street, the data collection process is complete. With this information the GIS operator can derive a mean value for pavement width. Then the operator can apply the appropriate offsets according to street right-of-way procedures and place the information into the geographic database.

II. State Highway Updates.

Mapping state highways and farm to market roads also begins with mission planning and the GPS antenna placed on the vehicle roof. In this situation, however, the antenna is placed on the driver's side and data is collected for the state or farm to market road center line. As the operator travels along the road he can obtain the right-of-way width information at certain intervals using manual methods of measuring. These measurements can provide a standard value for the state or farm to market road right-of-way. This data then can be placed into the geographic database.
4.0 SUBDIVISION POSITIONING

Currently DCEC provides electric service to over 280 subdivisions. Before the purchase of GPS the data available to precisely locate subdivisions within our geographic database was sometimes inadequate. For example, to precisely locate a subdivision, the plat would need to show a street intersection or survey distance from a street intersection common to both the plat and the geographic database captured from the U.S.G.S. quad. This information was not always available and other means of measurement were used such as aerial photos and/or field measurements. Now, with the aid of GPS, we acquire property corners or road alignments locations and use this information to register new subdivision plats. GPS has provided a more expedient means for the operator to precisely locate subdivisions.

5.0 FACILITIES INVENTORY

GPS has become a major player in facilities inventory at DCEC and has changed the way we look at positional accuracy. With an estimated 2,900 miles of distribution line spread across 1,200 square miles, GPS has made this seemingly impossible "POSITIONAL" task more manageable. With GPS we are able to construct a "REAL WORLD REPRESENTATION" of our electric facilities. Also with this technology we have expanded our inventory goals and have developed inventory procedures that are constrained more by our needs than by our limitations.

The following information will describe our procedures at DCEC. These procedures will evolve as needed to better suit our inventory needs.

1. Define inventory area with explicit boundaries. This information will be promulgated to all departments as "BEING INVENTORIED" and certain guidelines will be enforced when conducting work in this area which would affect the inventory.

2. Plot base maps consisting of planimetric features at a small scale, i.e. 1"=300'.

3. Draw rough field sketch of pole-line and any equipment on the plotted map.

4. Determine the positions to collect GPS data. These positions are termed "GPS CONTROL POINTS", and are collected at locations such as angle poles, dead end poles, tap poles or special equipment poles, i.e. regulator equipment or circuit breakers. GPS data is not collected at every pole but at key locations which gives adequate positional information on pole lines and keeps positional redundancy to a minimum.
5. Collect attribute information on each pole using a check off sheet. This sheet of paper contains a list of all items to be inventoried including Rural Electric Administration construction units along with GIS database symbol identification numbers. Geographic positional information is then downloaded from the GeoLink software for each GPS control point which was inventoried and then converted to our GIS format. This information contains latitude and longitude along with other descriptive information entered during the inventory which is used in a conversion process. With this map we are then able to fully construct the remaining pole line sketch.

6.0 CONCLUSION

There are many tools on the market today that interface with GPS. Some of these tools can be used in conducting inventory like those used at DCEC. These tools consist of bar code readers, programmable interface schemes and other data entry devices. Be wise in choosing the product line you wish to use. Remember, the more attribute information collected per entity the more cumbersome the data entry procedure becomes; keep it simple. Some data entry schemes may not be suited for your application. Take nothing for granted, ask questions, then ask more questions. Test the GPS equipment and the data entry procedures if you can and contact someone who is actively conducting an inventory similar to the one you wish to conduct. Happy mapping!