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MODELLING THE QUALITY OF GPS PLANIMETRIC POSITIONING

OUTLINE

1. INTRODUCTION
2. MAIN GOALS
3. EXPERIMENTAL TESTS
4. ANALYSIS OF RESULTS
5. MODELS
6. CONCLUSION

1- Introduction

- INTRODUCTION
- MAIN GOALS
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- CONCLUSION

GPS offers a three-dimensional positioning in a global reference frame

- availlable 24h
- independent of the meteorological conditions
- availlable over the globe.

Compared to the conventional methods, GPS offers several advantages:

- mainly the production
- the cost
- the precision
- time saving

1- Introduction

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GPS precision

GPS planimetric quality of positioning

- influenced by systematic and random errors,
- can reach the order of a centimetre or better depending on the type of equipment and the procedures used.

GPS planimetric positioning quality influenced by several factors

- ✓ troposphere effects,
- ✓ duration of observation,
- ✓ number of observed satellites
- ✓ satellites' constellation,
- ✓ baseline lengths and
- ✓ multipath effects.

2- Main Goals

- INRODUCTION
- MAIN GOALS
- EXPERIMENTAL TESTS
- RESULTS
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Assess the influence of certain parameters on GPS planimetric precision

- **Studying and modelling the influence of two parameters on the quality of GPS positioning,**

  Parameters are:
  - the duration of observation
  - the baseline length.

- Experimental tests :
  - using short and long baselines;
  - observations are done with four different durations of observation
  - data are collected using one and two frequency receivers

3- Experimental tests

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First set of experiences

- four **single-frequency** receivers,
- baseline lengths vary from 400 m to 1500 m,
- the durations of observations were 10, 20 and 30 minutes.

Second set of experiences

- four **single-frequency** receivers
- the baseline lengths vary from 3 km to 20 Km,
- durations of observations were 10, 20, 30 and 40 minutes.
- The set of points are some geodetic network points

Third set of experiences

- three **double-frequency** receivers
- baseline lengths vary from 3 km to 40 Km,
- durations of observations were 10, 20, 30 and 40 minutes with four **repetitions** for each duration of observation.
- The points used are another set of geodetic network points.

Post treatment:

- fast static mode
- interval of registration of 10s
- elevation mask of 15°
- PDOP mask is 5.

Planimetric positioning quality (Qp)

- It is expressed in terms of precision of x-y coordinates. - It is calculated as the square root of the sum of the variances of x & y coordinates.

$$Qp = \sqrt{(\sigma X^2 + \sigma Y^2)}$$

First set of experiences

- coordinates of points are computed by a least squares adjustment
- fixing the Lambert coordinates of one point as an adjustment constraint.

Quality of positioning

- varies between **2** and **6 cm** for 10 minutes of observation,
- less than **one cm** when the duration of observation varies between 20 and 30 minutes.
- the quality of positioning improves starting from 20 min of observations.

CCL: changing the baseline length from 400 m to 1500 m does not have significant effect on the quality of positioning. (figure 1)

4- Results

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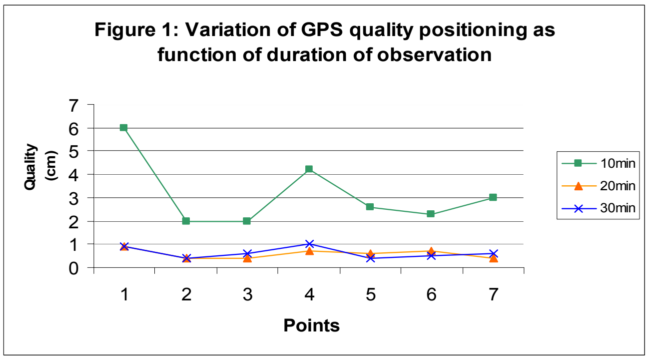
First set of experiences



4- Results

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Second set of experiences

Quality of positioning

we distinguish two separate cases:

- For baselines between 3 and 5 Km:
  - Qp varies from **2.9 cm** to **6 cm** for 10 minutes of observation.
  - Qp varies between **5mm** and **9 mm** for 20 and 30 minutes of observation.
- For baselines between 5 and 20 Km,
  - Qp varies from **3 mm** to **7 mm** for 10 and 20 minutes of observation.
  - Qp varies between **1 mm** and **3 mm** for 30 minutes of observation.

CCL: We can conclude that quality of position changes as function of the baseline length

4- Results

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Third set of experiences

For baselines between 20 and 40 km

- For 10 min of observation, Qp varies from 1.1 cm to 1.7 cm.
- for 40 min of observation, Qp varies between 0.7cm and 0.8 cm

-For the same duration of observation, any increase in the length of the baseline generates a slight deterioration of the position quality.

For 40 min of observation:

- For baselines between 3 and 5km: Qp varies between 0.1 cm and 0.2 cm
- For baselines between 5 and 20 km: Qp varies from 0.6cm to 0.8 cm

CCL: The increase in time observation implies an improvement in the quality of position.

5- Models

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MODELLING THE QUALITY AS FUNCTION OF DURATION OF OBSERVATION

Case 1: Modelling using the single frequency receivers

- Using the durations of observations and the quality of positioning obtained from the experimental tests;
- The curve of tendency corresponding to the experimental data and results is given by the following formula:

$$q_{TF1} = 0.0159e^{-0.0499T}$$

With :

q_{TF1} : quality of planimetric positioning with respect to time using one frequency receivers (in m)

T : duration of observation (in min)

e : the exponential function

MODELLING THE QUALITY AS FUNCTION OF DURATION OF OBSERVATION

Case 2: Modelling using the double frequency receivers

- Using the durations of observations and the quality of positioning obtained from the experimental tests;
- The curve of tendency corresponding to the experimental data and results is given by the following formula:

$$q_{TF2} = 0.0205e^{-0.0347\,T}$$

With :
q_{TF2} : quality of planimetric positioning with respect to time using double frequency receivers (in m)
T : duration of observation (in min)
e : the exponential function

Rq: **these models show that the quality of position improves as a function of the increase in the duration of observation**

MODELLING THE QUALITY AS FUNCTION OF THE BASELINE LENGTH

Case 1: Modelling using the single frequency receivers

- Observations are used to find the model corresponding to distances between **5 and 20km**
- The deducted model is valid only for this range of distances.
- The tendency curve corresponding to our data is given by the following model:

$$q_{DF1} = 0.0002 + 3.10^{-5}\,D(km)$$

With :
q_{DF1} represents the standard deviation of the distance in meters
D is the baseline length expressed in km.

5- Models

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MODELLING THE QUALITY AS FUNCTION OF THE BASELINE LENGTH

Case 2: **Modelling using the dual frequency receivers**

- all data used to find the next model correspond to distances between 3 and 30km
- the deducted model is valid only for this range of distances.
- the model expressing the variation of the quality with respect to the baseline length using two frequency receivers is given by:

$$q_{DF2}\,(m) = 0.0013 + 2.10^{-4}\,D(km)$$

With :

q_{DF2} represents the standard deviation of the distance in meters
D is the baseline length expressed in km.

6- Conclusion

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In this research paper

We conducted experimental tests using different variants such as:
- short and medium baselines;
- observations with four different durations of observation
- data are collected using single and double frequency receivers as well.

The achieved results were used for **modelling** the variation of the quality of GPS positioning with respect to:
- the duration of observation
- the baseline length, for both single and double frequency receivers.

The results of our experimental tests show that:

6- Conclusion

Variation of GPS planimetric position quality:

✓ For distances not exceeding 3 km, the change in the baseline length has insignificant effect on the positioning quality.
✓ For baselines between 5 and 40 km, the baseline length has a very highly meaningful effect on the quality of position

Modelling GPS planimetric position quality

✓ The GPS positioning planimetric quality could be expressed as an exponential trend function of the duration of observation, the quality of position improves when the duration of observation increases.
✓ There exists a proportional relationship between the duration of observation and the baseline length.

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THANK YOU FOR YOUR ATTENTION