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RESULTS OF COMPLEX PROCESSING GPS AND GLONASS DATA IN CASE OF RESTRICTED VISIBILITY OF NAVIGATION SATELLITES

This paper describes result of complex processing navigation data simultaneously received from GPS and GLONASS satellites. The issue of study is accuracy of coordinate calculations in case of limited number of visible satellites both systems. The conclusions about benefits of complex processing GPS and GLONASS navigation data are considered.

Introduction

The diversity and redundancy provided by multiple, independent, compatible and in some respects, interoperable GNSS such as GPS and GLONASS provide a lot of gain. There are scientific and practice interest in the research of positioning accuracy in case of complex processing navigation data received from satellites of both systems. The implementation of complex GNSS data processing is most important in situation of limited visibility of sky due to local obstacles. In some restricted conditions (fig. 1) combinations of visible satellites makes impossible determination of coordinates with the help of data from only one system.

For example, when visible only 3 GPS satellites and 2 GLONASS neither GPS nor GLONASS single-system receiver enable to determine own position. Receivers switch to mode of satellite searching and user cannot obtain renewed instant information about coordinates and velocity. Such situation is very dangerous for aviation and full of troubles for many over clusters of users. The lost of satellites signals in onboard GNSS receiver may take place during aircraft maneuvering in the terminal area. It is possible when own wing overshadows GNSS antenna placed over pilot cockpit. As a result crew may have difficult with correct estimation of flight altitude immediately after the turn.

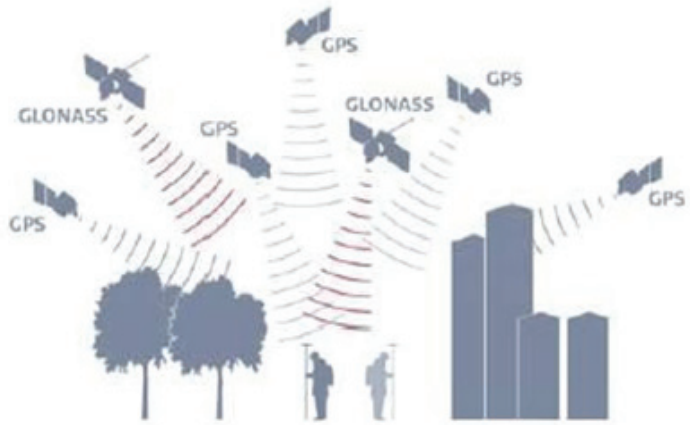

Fig.1 Restricted visibility of satellites due to local obstacles

Car drivers travelling at the mountain roads could lose satellite signal due to natural obstacles such as mountain peaks. Car navigator during some time wouldn't be able to calculate new coordinates and in its train the driver that uses electronic map would be misinformed about precise location at the road. Also if number of visible satellites from one system is equal or bigger than 4 but less than 6-7 it results in low level of positioning accuracy. Possible solution of this problem is adding data from other navigation system. For example, we can use as additional sources of range data satellites from other satellite navigation system (GPS as additional for GLONASS, or GLONASS as additional for GPS).

Simulation and its results

The aim of research is estimation of positioning accuracy obtained after complex processing GPS and GLONASS data in case of restricted visibility of navigation satellites. It means that total number of satellites should be 5-6. For purposes of simulation such conditions could be achieved with the help of receiver ProPack-V3 software.

There is a built-in command LOCKOUT that allows exclude any satellite from visible constellation.

Fig. 2 shows the general algorithm of research. It combines facility for receiving real navigation data from visible GPS and GLONASS satellites and developed software for complex processing available navigation data and computing position. Obtained results are compared with known coordinates of receiver location for determination of instant accuracy.

Features of complex processing data from two satellite systems impose follow limitations for satellite combinations:

- each system should be provided with minimum 2 satellites;
- minimal total number of both system satellites is equal 5.

So follow combinations of GPS and GLONASS satellites were simulated and researched: 3+2 (fig. 3), 2+3 (fig. 4), 3+3 (fig. 5), 4+2 (fig. 6) and 2+4 (fig. 7).

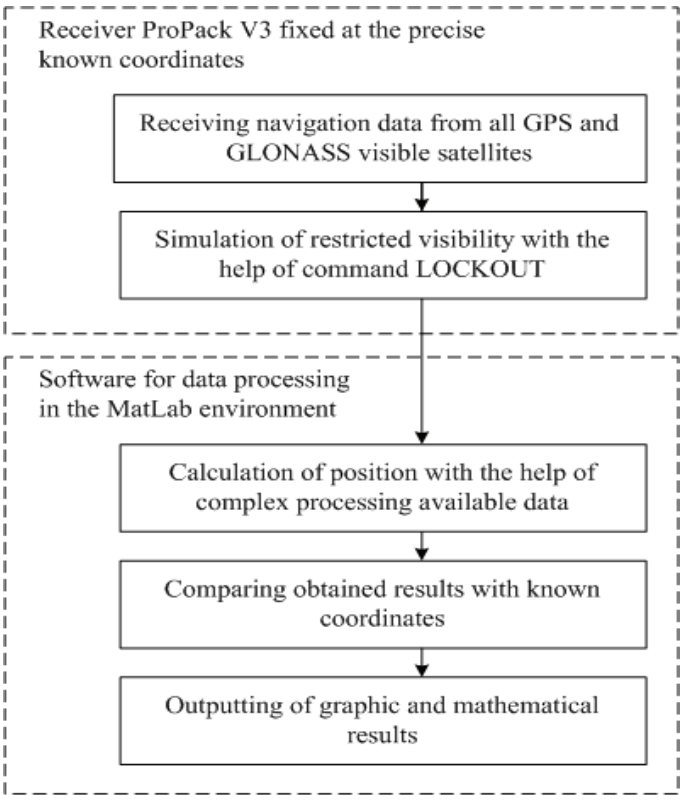

Fig.2 General algorithm of research

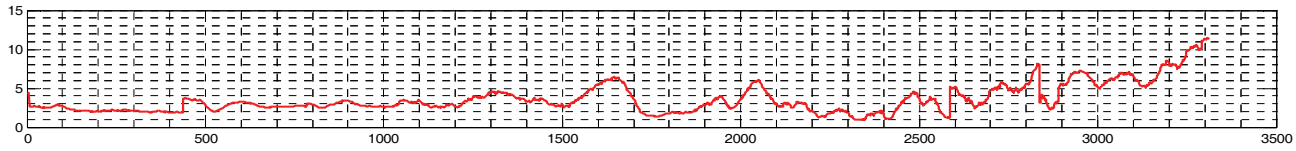

Fig. 3 Instant accuracy for satellites combination 3GPS + 2GLONASS

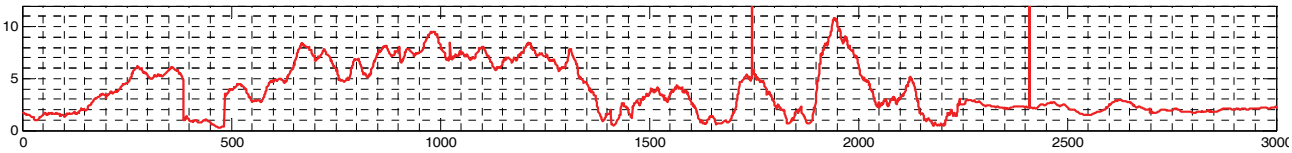

Fig. 4 Instant accuracy for satellites combination 2GPS + 3GLONASS

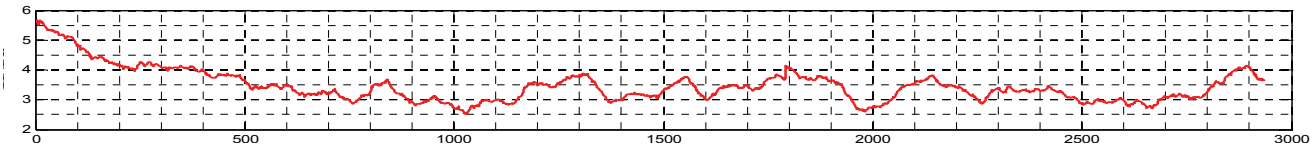

Fig. 5 Instant accuracy for satellites combination 3GPS + 3GLONASS

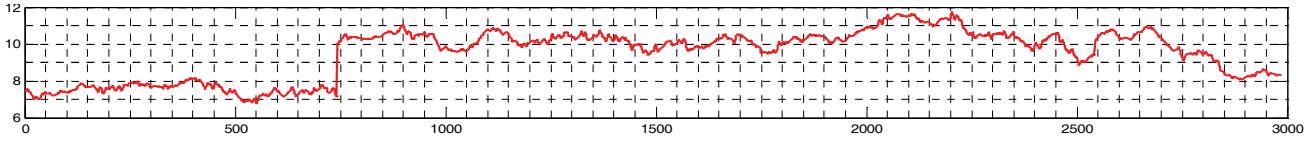

Fig. 6 Instant accuracy for satellites combination 4GPS + 2GLONASS

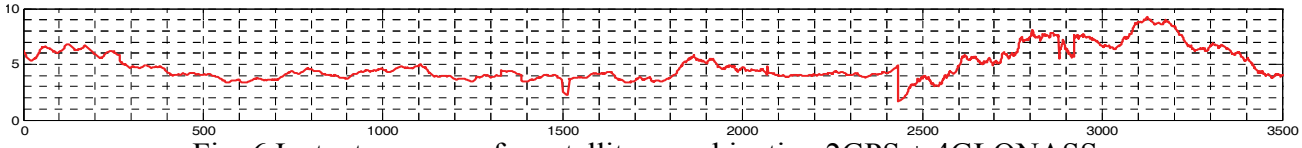

Fig. 6 Instant accuracy for satellites combination 2GPS + 4GLONASS

Table 1 contains results of mathematical processing obtained data.

Table 1.

Parameter	Accuracy of positioning for satellite combinations				
	3+2	2+3	3+3	4+2	2+4
Max error, m	2.767	20.08	5.664	11.694	9.264
Min. error, m	-7.004	0.28	2.527	6.800	1.709
Expected value of error, m	-1.366	3.802	3.460	9.507	4.899
Variance, m^2	2.955	14.309	0.298	1.705	1.920
Standard deviation, м	1.719	4.828	0.546	1.306	1.386

Analysis of the results shows that maximal value of positioning error was 20 m, the expected value of coordinate error in the experiments did not exceed 10. The average value of standard deviation was less than 2 m, which suggests that a 95% deviation in determining the location does not exceed a value of 3 m, and 99% - 3.7 m maximum deviation of 4.8 m occurred configuration 2GPS +3 GLONASS.

Conclusions

Complex processing navigation data from GPS and GLONASS satellites allowed to calculate coordinates of user with medium level of errors. This result was obtained for simulated conditions of restricted visibility of navigation satellites than the maximal number of both system satellites was 6. It proved the advantage of complex processing navigation data – the possibility to calculate coordinates than single-system receiver (GPS or GLONASS) enable to perform this task due to low number of visible satellites.

References

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