Stability of the Reference Frame for Structural Monitoring Applications Using GNSS

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SUMMARY

Nowadays, GNSS technology can be a useful tool, not only for navigation and location aspects, but also for precise positioning applications, such as monitoring of structures. This technique permits an all-weather continuous remote control as well as a quite low cost, both for instrumentations and for monumentation aspects.

The traditional approach to GNSS monitoring is based on a relative positioning between a reference station, assumed as stable, and a rover one.

Rover and reference stations can be situated at short distance, in order to obtain high accuracy with L1 receivers.

For data processing, several software packages are available, both by GNSS manufacturers and by scientific institutions. Recent free and open source software packages, such as RTKLIB and GoGPS, are particularly interesting because they allow a much higher level of customization of the data processing and post processing phases and, for short distances, they offer performances comparable with those of more consolidated softwares, such as Bernese, Gamit, etc…

The continuous monitoring based on a daily position estimation produces a time series that can be useful both for structure stability studies and for "early warning" systems.

In this paper, several aspects related to the monitoring problem using GNSS have been investigated using a GNSS receiver located on the top of the Garisenda tower (Bologna, Italy) since October 2013.

oriously affected by problems of stability and has already been monitored using different techniques, such as inclinometer, spirit levelling etc...

The acquired data, amounting to a couple of years, have been processed starting from four GNSS reference stations located in different parts of Bologna, but each one at a maximum distance of 2km from the tower.

Assuming each reference station as stable, a single base data processing has been performed and four time series have been obtained. After a phase of outliers detection and removal, mean velocities for each time series have been estimated using a least squares approach. A comparison of the mean velocities shows significant differences, probably due to some instabilities of the reference stations.

Therefore, each reference station has been processed and a model for each reference station has been defined using Precise Point Positioning approach; the solutions have been aligned to the ETRF using local parameters transformations, generated by a regional network of 16 stations that covers the Italian peninsula and the bordering Countries. The models obtained have been considered for a new data processing and new mean velocities of the Garisenda station have been estimated. The new time series have a higher level of accuracy than the previous series.

Despite that improvement in the level of agreement between the four solutions, some differences are still present. This work reports a proposal concerning more complex analysis, with the aim to improve solutions and results interpretation.