RECENT DEVELOPMENTS IN PRECISE POINT POSITIONING

S. Bisnath[1] and P. Collins[1,2]
[1]Department of Earth and Space Science and Engineering, York University, Toronto, Ontario
[2]Geodetic Survey Division, Natural Resources Canada, Ottawa, Ontario

In standard Precise Point Positioning (PPP), the carrier phase ambiguities are estimated as real-valued constants, so that the carrier-phases can provide similar information as the pseudoranges. As a consequence, it can take tens of minutes to several hours for the ambiguities to converge to suitably precise values. Recently, new processing methods have been identified that permit the ambiguities to be estimated more appropriately as integer-valued constants, as they are in relative Real-Time Kinematic (RTK) positioning. Under these conditions, standard ambiguity resolution techniques can be applied to strengthen the PPP solution. The result can be a greatly reduced solution convergence and re-convergence period, representing a significant step toward improving the performance of PPP with respect to that of RTK processing. This paper describes the underlying principles of the method, why the enhancements work, and presents some results.

*Dans le positionnement ponctuel précis (*Precise Point Positioning *- PPP) conventionnel, les ambiguïtés de la phase de la porteuse sont estimées sous forme de constantes en valeurs réelles, de manière à ce que la phase de la porteuse puisse fournir des renseignements semblables à ceux des pseudodistances. En conséquence, il peut falloir entre quelques dizaines de minutes et plusieurs heures pour que les ambiguïtés convergent en valeurs de précision convenable. Récemment, on a identifié de nouvelles méthodes de traitement permettant d'estimer de manière plus appropriée les ambiguïtés sous forme de constantes en valeurs entières, tout comme dans le positionnement relatif cinématique en temps réel (*Real-Time Kinematic *- RTK). Dans ces conditions, les techniques standard de résolution des ambiguïtés peuvent être appliquées pour renforcer la solution du PPP. Il peut en résulter une réduction considérable de la période de convergence et de reconvergence de la solution, ce qui représente un grand pas vers l'amélioration du rendement du PPP relativement à celui du traitement du RTK. Le présent article décrit les principes sous-jacents de cette méthode, explique les raisons pour lesquelles les améliorations fonctionnent et présente quelques résultats.*

S. Bisnath
sbisnath@yorku.ca

P. Collins
pcollins@nrcan.gc.ca

Introduction

Precise Point Positioning (PPP) originated as a Global Positioning System (GPS) data processing technique that utilizes dual-frequency pseudorange and carrier-phase observations from single GPS receivers combined with precise satellite orbit and clock corrections to provide precise estimates of 3D position, time and atmospheric water vapour. *Héroux and Kouba* [1995] used the term Precise Point Positioning for the technique of processing pseudoranges, and *Zumberge et al*. [1997] developed the contemporary technique as an efficient method of processing pseudorange (or code) and carrier-phase (or phase) measurements from large networks of static GPS reference stations. In recent years, a number of governmental, academic and commercial PPP services have been developed for various applications.

A key point of interest has been whether the absolute PPP technique can be made to work as well as the relative Real-Time Kinematic (RTK) technique. RTK refers to the GPS mode of operation in which the vector between two receivers is determined through the process of "double-differencing" the carrier-phase observables to reduce or eliminate many error sources in the data. The major limitation in the wider use of PPP is the solution convergence and re-convergence period, which can range from minutes to tens of minutes to hours, depending on the desired positioning performance and the quality and quantity of input measurements. In the past few years, researchers [e.g., *Bisnath and Gao* 2007] have asked openly if PPP solution convergence can be greatly reduced; that is, can PPP perform more like RTK? A number of researchers have been making inroads towards an answer to this question, and the primary purpose of this paper is to describe these advances and explain why they work.

This paper will begin with an introduction to the PPP technique and current applications. Attention will be focused on recent research developments, specifically ambiguity resolution, and new ideas for the management of ionospheric refraction. with the conclusion will discuss future prospects for the technique.