Implementation of Multipath Channel Reduction Models for the realistic Testing of GNSS Receivers.

PhD defence of Florian RIBAUD

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Auditorium
ONERA Toulouse
2 Avenue Édouard Belin
31000 Toulouse

Jury

- Prof. Terry MOORE, University of Nottingham, England (Reviewer)
- Prof. Claude OESTGES, Université catholique de Louvain, Belgium (Reviewer)
- Dr. Olivier JULIEN, ENAC, Toulouse, France (Co- director)
- Prof. Fernando PEREZ-FONTAN, Universidad de Vigo, Spain (Co- director)
- Dr. Sébastien ROUGERIE, CNES, France (Examiner)
- Dr. Joel LEMORTON, ONERA Toulouse, France (Invited)

Abstract

This PhD work relates the development of multipath channel reduction methods, putting the emphasis on the preservation of the signal tracking performances of satellite navigation systems. It aims at adapting the models of land mobile channel to the realistic testing of GNSS receivers, by reducing drastically the number of multipaths of the original channel (from thousands to less than 10 typically) all by conserving the pseudo-range error.

Three types of methods have been investigated in order to cover all different possibilities of reduction processes. As a first approach, a multipath aggregation method has been considered, through the clustering of the multipaths according to the delay and Doppler dimensions, weighted by their power. Even if this method allows a good preservation of the delay and Doppler characteristics of the original channel, a second approach has been investigated, oriented toward the optimization of the parameters of the reduced channel (delay, Doppler shift, phase and amplitude) in order to minimize the difference between the original channel correlation function and the reduced one. Even if this approach gives good performances in terms of pseudo-range error preservation, it leads to the instability of the reduced channel echoes. Therefore, a statistical method has been implemented, considering that the delays of the reduced channel evolve according to a first order Markov process.

These three approaches have been compared through the preservation of the discriminator open loop error. In particular conditions concerning the number of echoes in the reduced channel or the elevation of the emitter satellite, the clustering technique implemented in first approach appears to equal the performances of the parametric method, the statistical approach giving systematically the worst performances. The invariance of this hierarchy as adding tracking loops to the simulation or changing the signal model (modulation and RF bandwidth) allows extending the conclusion.

Being given the significant advantage of the Clustering on the parametric method in terms of computation time, the use of this method is preconized to address the channel reduction problem. In particular, the weighted clustering technique developed in this thesis offers the possibility to reproduce the wide-band characteristics of a channel model composed of thousands of multipaths with less than 10 echoes. Moreover, it constitutes an interesting tradeoff between computational effort and GNSS systems pseudo-range error conservation, approaching the performances of parametric methods, and even overcoming them in some conditions, with a computation time close to the real time.

Key words

Multipath - Channel – Reduction - GNSS