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DESIGN AND VALIDATION OF A SOFTWARE RECEIVER FOR GALILEO

Abstract

This paper presents a new version of software-based GNSS receivers for the Binary Offset Carrier (BOC) signals of the upcoming Galileo system. The receiver designed has proven to be able to acquire, track and demodulate signals from both satellites. The advantages in terms of flexibility and reconfigurability make the software receiver an excellent instrument to test new designs or new prototypes as a previous stage on a hardware implementation.

A software GNSS receiver consists in three main modules: acquisition, tracking and computation of the navigation solution. In this contribution, we focus on different techniques for the acquisition and tracking modules to determine the most efficient in terms of complexity and performance.

Three different techniques have been studied for the acquisition module: Serial Search, Parallel Frequency Space Search and Parallel Code Phase Search. After intensive simulations, the Parallel Code Phase Search technique was selected because it requires the smallest number of iterations to converge with a consequent saving on the processing time required as it parallelizes the code phase search using a circular correlation method in the Fourier domain. Also, it outperforms the other two approaches in terms of the accuracy in the estimation of parameters.

The tracking module is composed of a Costas loop and a DLL (Delay Lock Loop) for carrier and code tracking, respectively. As a new feature, the carrier loop uses an extended arctangent as discriminator for tracking the pilot channel (E1C) instead of a conventional one. Extended arctangent discriminator offers a larger linear margin from $-\pi$ to π although it is also resource demanding. Parameters values of the tracking process are estimated by means of simulation.

Regarding the DLL, the BOC-PRN (E+L) scheme has been selected for its ability to avoid ambiguity on the signal tracking proper of Galileo BOC signals.

In order to validate the performance of the proposed receiver in a real scenario, a extensive measurement campaign using Giove-A and B satellites has been carried out. These tests have been done in different scenarios around the Telecommunication Engineering School of the Technical University of Madrid, Spain (40.45N, -3.7267W). The selected scenarios are: open-area, outdoor and indoor. Several passes were considered in order to have diverse conditions of elevation and visibility.

Measurements have been done using a commercial GNSS RF front-end to capture signals and deliver them to a PC for acquisition, tracking and demodulation using the proposed receiver algorithms.