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Cycle Slips Detection in Quad-Frequency Mode: Galileo's Contribution to an Efficient Approach under High Ionospheric Activity

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Cycle slips detection has always been a key issue in phase measurements accuracy, thus impacting positioning precision. Since Galileo is the first constellation to offer four carrier frequencies available in Open Service, we were able to develop an innovative detection algorithm, especially promising in harsh environment like high ionospheric activity. This improves previous dual and triple-frequency methods, whose efficiency was somehow limited in tricky situations, like ionospheric events or particular configurations.

In our algorithm, two types of testing quantities were used: triple-frequency Simsky combination and dual-frequency Geometry-Free combination, each one being associated to a suitable detection algorithm. Simsky combination allows to detect almost every configuration, except for cycle slips of the same magnitude, appearing simultaneously on all carriers. Geometry-Free combination is only used to detect this particular case, since it suffers from quick variation of ionospheric delay. Together - through the choice of the most efficient combination alternatives - they enable the detection of any cycle slips configuration. This is now made possible thanks to the availability of data from Galileo's four carriers.

The quad-frequency algorithm has been tested on Galileo observations from both GMSD (Japan) and NKLG (Gabon) stations. On the first ones, cycle slips were artificially inserted in order to simulate particular cases and test algorithm robustness. NKLG raw data were used to assess algorithm behaviour for cases met in the equatorial area.

Enhanced with a suitable cycle slip correction method and a real-time feature, our algorithm could directly be integrated into the software receiver, enabling the supply of continuous and corrected data to the user.

In conclusion, this first quad-frequency cycle slips detection algorithm is obviously a step forward and every Galileo user will indeed be able to benefit from a highly better-quality positioning. With regard to precise positioning, this is yet another step reinforcing Galileo's competitivity against other dual or triple-frequency GNSS.