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» Abstract

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»Abstract

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Category	Signal Interference and Multipath
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Title of the Paper	Detection, Identification and Mitigation of Outliers in Receiver Autonomous Integrity Monitoring (RAIM) by Solving Observation Equations
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Abstract	<p>The conventional RAIM based on the least square algorithm of the residuals of the snapshot data can detect the single outlier almost perfectly, but it can miss the multiple outliers. We must clarify this problem, and develop a method to prevent the missed detection of the multiple outliers. In the present paper, a method to detect multiple outliers correctly is obtained, and the numerical results seem reasonable and appropriate. The magnitude of the outliers is also estimated, and this makes the positioning more accurate.</p> <p>In the present paper, the problem is reexamined from the very basic level, and a new method is proposed for outlier detection. The observation equation for code signals including outliers is transformed into a minimum value problem, where not only the outliers but also the number of the outliers is one of the unknowns. However, there can exist false solutions to the problem, and we must choose a real solution among them. So, in the present method, a constraint to the solution is introduced. The outliers are assumed positive or negative according to the definition. Under this constraint, the numerical results seem reasonable and appropriate. A complete solution without imposing any constraints may however require introduction of information other than residuals.</p> <p>The constraint condition is required by the following reason. If outliers are generated by multi-path of the signals, they should be positive or negative according to the definition. In the present paper, the delay of the signal corresponds to the positive outlier. So, the outliers due to multi-path of the signals are detected as positive outliers. And, if any abnormality in the ionosphere or troposphere occurs, it will also be detected as a positive outlier, since the code signal is delayed by the abnormality in the ionosphere or troposphere.</p> <p>As an numerical example, we studied the data downloaded from the homepage of ARGN (Australian Regional GPS Network, http://www.ga.gov.au/bin/data_server/). Data obtained on Nov. 6, 2006 (0:00:00 GPS time) for station Tow2 (Townsville) are analyzed. Nine satellites, that is, 3, 6, 7, 14, 15, 16, 18, 21 and 22 are used. We modified data to include the outliers. We assumed three cases including one, two and three outliers. In these cases, the conventional RAIM based on the least square algorithm of the residuals of the snapshot data can not detect the outlier correctly. The present method solved the three cases correctly. The constraint introduced in the present method played a big role. Without the constraint, we couldn't get the correct result when the number of the outliers is three.</p> <p>Mathematically, the outlier can't be determined from the residual in general. Some kind of outliers make residual zero. So, this kind of outliers may not be detected by checking the residuals.</p>
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