International Journal of Innovative Computing, Information and Control
Volume **1**, Number **3**, September **2005** ISSN 1349-4198
pp. 461–478

FAULT DETECTION IN CARRIER PHASE GPS POSITIONING BASED ON HYPOTHESES TESTING OF INNOVATION PROCESSES

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Received November 2004; revised April 2005

Abstract. *This paper proposes an anomalous measurement detection algorithm as a part of the quality control of the GPS (Global Positioning System) positioning based on statistical tests of the innovation processes of the Kalman Filter. The algorithm is developed for dual (or more) frequencies, carrier phase real time kinematic positioning using the Kalman filter and the LAMBDA (Least squares AMBiguity Decorrelation Adjustment) ambiguity resolution method. The algorithm can efficiently detect anomalous measurements, and it is useful to maintain highly accurate positioning. The experimental results of positioning by using real receiver data show the feasibility of the presented algorithms.*
Keywords: GPS, Positioning, Fault detection, Kalman filter, Innovation

1. **Introduction.** The quality of GPS positioning strongly depends on a number of factors. In order to attain continuous precise (sub-centimeter level accuracy) positioning results with carrier phase measurement, it is required that the integer ambiguity is correctly resolved, and error unspecified as a functional or stochastic model have to be detected and efficiently corrected or removed. For data processing, cycle slips, receiver clock jumps, ionospheric, and multipath effects are the main sources that can deteriorate the quality of the measurements and the quality of the positioning. If these errors exist, jumps and biases in the positioning results may appear.

In recent years, the above problems have been extensively investigated. For some representative work on this general topic, to name a few, we refer readers to [1–9]. Especially in the work of [6], the multipath error detection algorithm is derived by applying the χ^2-test of the innovation processes of the Kalman filter.

For the kinematic GPS positioning, the integration of the Kalman filtering and the LAMBDA method [1,10] is a natural choice for ambiguity resolution and positioning of a moving vehicle such as car, aircraft, ship etc. [2, 3]. The concept introduced in [2] is that the Kalman filter is run undisturbed, and its outputs are used at each measurement epoch to resolve the integer set and the navigation solution at that epoch. And the authors of [2] call the method "optimum" in terms of resolving integers at every epoch. However, as also mentioned in [2], the method is not "optimum" in any practical cases because there exist errors in the system dynamics and the measurements, e.g. cycle slips, residual ionospheric and tropospheric effects. It is also reported that the method