Error bounds of the GNSS/INS integrated system against GNSS fault for integrity monitoring

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ABSTRACT

This paper introduces an Extend Kalman filter (EKF) innovation-based error bounds against Global Navigation Satellite System (GNSS) fault of the tightly coupled GNSS/Inertial Navigation System (INS) integrated navigation system. A new GNSS/INS integrity monitoring framework and integrity risk allocation tree under the fault assumption are developed to assure the integrity of the unmanned aerial vehicle (UAV) navigation systems. The error bounds of the error-state EKF are obtained according to the GNSS fault propagation derivation. This research then presented an EKF innovation-based fault detection method with the chi-square test statistics for the large step fault detection. The minimum detectable error (MDE) is also proposed to determine the upper bound on the probability of the hazardous misleading information. Simulation results show that the error bounds can fit the state error and reflecting the position error change caused by the GNSS fault in real time, which can be accurately overbounded during UAV operations under the missed detection probability requirement. The error bounds against GNSS fault enable direct and rigorous integrity risk evaluation, which can be used to assure the integrity of the GNSS/INS integrated architecture for an UAV.

1 INTRODUCTION

GNSS/INS integrated systems are widely used in both military and civilian areas. The Unmanned Aerial Vehicles (UAVs) are the best example of a specific application of the GNSS/INS integrated system, which have a wide application prospect. Meanwhile, the reliability and safety of GNSS/INS integrations are becoming a greater concern in the community and a critical and challenging

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