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THREE-CHANNEL FILTER THEORY FOR FAULT DETECTION AND ISOLATION OF
REDUNDANT INERTIAL MEASUREMENT UNIT**Abstract**

The fault detection and isolation(FDI) of redundant strapdown inertial measurement unit is critical for ensuring the reliability of the guidance or navigation system both in the fields of aeronautics and astronautics. Although parity space approach is used widely, it is impossible to detect the soft fault because of pulses quantization. This paper aims at three-channel filter parameters design to solve the problem that conventional parity space method cannot detect soft fault correctly after quantization, proposes the constraint conditions of filter design and accomplishes the FDI three-channel filter theoretically in a deep level using parity space approach. Different amplitudes of faults should have different detection strategies. This paper conducts theoretical derivation to three-channel filter theory. The original data detection channel is used to detect the hard fault, the first-order filter is used to detect the medium fault, and the second-order is used to detect the small fault. Therefore parity vector is firstly given into three-channel to conduct pretreatment parallel, and then carry out comprehensive judgment according to the FDI algorithm. Due to the parameters of the filter are related to the turning frequency and the rise time of the system, Therefore, the constraint conditions of the designed filter are proposed based on the analysis of the relationship between the turning frequency and the filters' rise time, In this paper, the mathematical equation of the filter parameters is obtained through the theoretical derivation of the filter parameters. Monte Carlo simulation is carried out in order to verify the validity of the theory. Results on the one hand show that with the increase of the filtering parameters, the false alarm rate and the false isolation rate will be reduced, whereas the system cannot be detected in a short time. For the other hand, the results also indicate that different magnitudes of the faults have different FDI performance as for the same parameters. The smaller fault amplitude would have worse FDI performance. Consequently, the proposed theory is feasible and can provide a theoretical reference for choosing reasonable weight of rise time and turning frequency respectively to improve the performance of the FDI system.