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Anti-disturbance fault tolerant initial alignment for inertial navigation system subjected to multiple disturbances[☆]

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Abstract

Modeling error, stochastic error of inertial sensor, measurement noise and environmental disturbance affect the accuracy of an inertial navigation system (INS). In addition, some unpredictable factors, such as system fault, directly affect the reliability of INSs. This paper proposes a new anti-disturbance fault tolerant alignment approach for a class of INSs subjected to multiple disturbances and system faults. Based on modeling and error analysis, stochastic error of inertial sensor, measurement noise, modeling error and environmental disturbance are formulated into different types of disturbances described by a Markov stochastic process, Gaussian noise and a norm-bounded variable, respectively. In order to improve the accuracy and reliability of an INS, an anti-disturbance fault tolerant filter is designed. Then, a mixed dissipative/guarantee cost performance is applied to attenuate the norm-bounded disturbance and to optimize the estimation error. Slack variables and dissipativeness are introduced to reduce the conservatism of the proposed approach. Finally, compared with the unscented Kalman filter (UKF), simulation results for self-alignment of an INS are provided based on experimental data. It can be shown that the proposed method has an enhanced disturbance rejection and attenuation performance with high reliability.

Keywords: Inertial Navigation System, Fault Tolerant, Filter, Initial Alignment, Robustness, Multiple Disturbances.

1. Introduction

An Inertial Navigation System (INS) is a dead reckoning system that uses gyroscopes, accelerometers and a navigation computer to continuously calculate navigation parameters of

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