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THE RESEARCH OF DETECTING THE OUTLIER IN DATA PROCESSING OF RELATIVE NAVIGATION OF TIGHT FORMATION FLYING

Abstract

In order to meet with different mission requirements, autonomous control of tight formation flight requires high precision relative navigation. It's also worth mentioning that there is al least dm-level accuracy of semi-axis deviation in some distributed SAR satellite space system. But for hardware-in-the-loop simulation or orbital running mission of formation flight,there always are measurement outliers, e.g. uncerntainty random noise, wild values, time hopping and data loss, which could detrimentally effect on convergence and stability of relative navigation algorithm. Simple methods such as the Out-Of-Limit (OOL) check, the 3σ check, and second order difference check, which only verify if a certain parameter crosses soft(hard) upper or lower thresholds, is not robust enough to detect the various types of outliers. Many researchers had taken a different approach to detect more types of outliers. Ramaswamy et al [2000] take the kNN distance of a point as its outlier score. Harvey J Motulsky and Ronald E Brown [2006] Detecting continuous outliers when fitting data with nonlinear regression. Kriegel et al. [2008] develop angle-based outlier degree method where Object o is an outlier if most other objects are located in similar directions. Corey O'Meara et al. [2016] apply Supervised Machine Learning which computes large (dimension greater than 4) feature vectors to deal with various situations. It is difficult for above mentioned methods to deal with various types of outlier at the same time. And if using the complicate methods to deal with the various type of outlier at the same time. And if using the complicate method requires so much calculation that it's hardly applied to detect outliers in real time on board. This paper is organized as follows: Section 1 generally introduces the background, motivations and contributions of this paper. We will compare different detection methods by processing measured relative navigation data in section 2, all data was gathered in hardware-in-the-loop emulation. Then we propose a strategy that combines two-order differential method and regression analysis to detect outliers of different distribution. Finally, we use the navigation data with various outliers to validate the proposed strategy in last section, which can speed convergence up and enhance the stability of filtering.