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An online batch-based fusion filter for navigation in Mars final approach phase

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Statement of the Problem: An accurate knowledge of Mars entry condition is significant for a successful aerocapture and pinpoint landing. However, the traditional navigation scheme during the final approaching phase based on the Deep Space Network cannot achieve an accurate result because of the severe time delay. Navigation based on the X-ray pulsars has been proposed to improve the navigation performance. But highly nonlinear dynamic model and relatively low updating rate of measurement may result in filter divergence.

Aim: The purpose of this study is to develop a novel online Batch-based Fusion Filter (BFF) dealing with the difficulties in Mars final approaching phase.

Methodology & Theoretical Orientation: In the algorithm, a batch-based estimation method with fixed batch length is developed to optimally determine the state of spacecraft. Unlike the traditional moving horizon estimation, only the cost function of previous measurements is used so that the differential correction method can be used. The computation cost is also reduced. To incorporate a priori information of state, a data fusion process is also employed. The stability and accuracy of batch-based estimation method is discussed, and the factors affecting the position and velocity estimation accuracy are also investigated.

Findings: The configuration of X-ray pulsars is a main contribution to the estimation error. The navigation pulsars should be carefully chosen to guarantee an accurate estimation. If three pulsars are used the direction of three pulsars should be orthogonal, which is identical to the analysis result using Fisher information matrix.

Conclusion & Significance: The proposed online Batch-based Fusion Filter gives a potential solution to the navigation for Mars final approaching phase. If the configurations of pulsars are carefully chosen, the navigation performance can also be further improved. The accuracy analysis method can also be extended to other navigation schemes based on relative position measurements.

Biography

Zhengshi Yu completed his PhD at Beijing Institute of Technology. He was a Research Scholar at University at Buffalo and worked on "The guidance, navigation, and control technologies for deep space exploration". Now, he is pursuing his Post-doctoral Degree at Beijing Institute of Technology. He has his expertise in "Optimal estimation, trajectory optimization, autonomous guidance, navigation and control system, and image processing". Now, he is working on "The innovative navigation, guidance and control method for Mars EDL phase and small body exploration". He is the Project Leader of National Natural Science Foundation of China and China Postdoctoral Science Foundation Project.

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