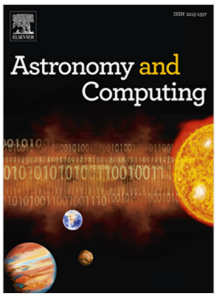
Accepted Manuscript



Robust integrated navigation for Mars atmospheric entry with parameter uncertainties

H. Yang, H. Fu, Z. Wang, Q. Xiao, Y. Zhang

PII: S2213-1337(16)30132-9
DOI: http://dx.doi.org/10.1016/j.ascom.2017.06.003
Reference: ASCOM 194

To appear in: *Astronomy and Computing*

Received date : 22 November 2016
Accepted date : 23 June 2017

Please cite this article as: Yang, H., Fu, H., Wang, Z., Xiao, Q., Zhang, Y., Robust integrated navigation for Mars atmospheric entry with parameter uncertainties. *Astronomy and Computing* (2017), http://dx.doi.org/10.1016/j.ascom.2017.06.003

Robust Integrated Navigation for Mars Atmospheric Entry with Parameter Uncertainties

Haifeng Yang[a], Huimin Fu[b], Zhihua Wang[c], Qiang Xiao[d] and Yongbo Zhang[e]

Abstract:

Mars atmospheric entry is a key phase to actualize Mars pinpoint landing. In this phase, parameters including atmospheric density, ballistic coefficient and lift-to-drag ratio (LDR) are uncertain for the reason of environmental complexity. Ignoring these uncertainties may probably cause negative effects on the navigation accuracy. Baesed on the desensitized unscented Kalman filter (DUKF), which obtains the state estimation by minimizing a cost function involving the trace of posterior covariance matrix and the weighted norm of the posterior state estimation error sensitivities, this paper further introduces parameter uncertainties into the radio beacons/inertial measurement unit (IMU) integrated navigation scheme, and establishes a robust integrated navigation for Mars atmospheric entry with parameter uncertainties. Numerical simulation results show that the robust navigation algorithm based on the DUKF effectively reduces the influence of parameter uncertainties and illustrates a better performance than traditional methods.

Keywords: Mars atmospheric entry, Uncertain parameters, Parameter sensitivity, Desensitized unscented Kalman filter

1. Introduction

Mars exploration is an important part of human deep space explorations. An increasing number of countries and international organizations have been focusing on relative technologies, especially the Mars pinpoint landing activities with a landing accuracy within 100m to the target [1,2]. As the longest and extremely dangerous phase during the complete landing process, Mars atmospheric entry is of key importance to actualize the pinpoint landing [3-5]. Therefore, it has become a hot international research issue to improve the navigation accuracy during this phase, and the literature has mainly relies on advanced navigation, guidance, and control techniques [6,7].

Mars atmospheric entry navigation algorithm normally consists of the dynamic model, the measurement model and the Kalman filter [8]. The dynamic model is utilized to simulate force conditions of the vehicle in the real

[a] 1 Ph.D. Student, Research Center of Small Sample Technology, Beihang University, Beijing 100191, China (corresponding author). E-mail: halfyang@buaa.edu.cn

[b] Professor, Research Center of Small Sample Technology, Beihang University, Beijing 100191, China. E-mail: fuhuimin@263.net

[c] Corresponding Author, Assistant Professor, Research Center of Small Sample Technology, Beihang University, Beijing 100191, China. E-mail: wangzhihua@buaa.edu.cn

[d] Engineer, Beijing Institute of Space Launch Technology, China Academy of Launch Vehicle Technology, Beijing 100010, China. E-mail: qiangxiaobuaa@163.com

[e] Assistant Professor, Research Center of Small Sample Technology, Beihang University, Beijing 100191, China. E-mail: zhangyongbo@buaa.edu.cn