An Investigation Into Cubature Kalman Filter Performance for Orbit Determination Application

Show affiliations

Pardal, Paula C. P. M.; **Koiti Kuga, Helio**; **Veloso Garcia, Roberta**

The purpose of this work is to discuss the Cubature Kalman Filter (CKF) performance when applied to a high nonlinear problem: artificial satellites orbit determination, using real Global Positioning System (GPS) data. The CKF is a discrete-time nonlinear Bayesian filter based on a third-degree spherical-radial cubature rule, which allows to numerically computing multivariate moment integrals in the Bayesian filter. In particular, it also provides a set of cubature points scaling linearly with the state vector dimension. As a result, the CKF yields a systematic solution for high dimensional nonlinear filtering problems, such as the orbit determination addressed here. In this work, the application consists of determining the orbit of an artificial satellite, using real data from the GPS receivers. This is a nonlinear problem, with respect to the dynamics and measurements equations, in which the disturbing forces are not easily modeled. The problem of orbit determination consists essentially of estimating values that completely specify the body trajectory in the space, processing a set of observations that can be collected through a tracking network grounded on Earth or through sensors, like space GPS receivers onboard the satellite. The GPS is a widespread system that allows computation of orbits for artificial Earth satellites by providing many redundant measurements. Throughout an onboard GPS receiver, it is possible to obtain nonlinear measurements (pseudoranges) that can be processed to estimate the orbital state.The standard differential equations describing the orbital motion and the GPS measurements equations are adapted for the nonlinear filter so that the CKF algorithm is also used for estimating the orbital state.The assessment to be presented will be based on the robustness of the filter, concerning convergence speed when the measurements are scattered. The results from CKF will be compared to the unscented Kalman filter (UKF) results for the same problem, in computational terms such as convergence and accuracy. Based on the analysis of such criteria, the advantages and drawbacks of the implementations are presented.

Publication:
42nd COSPAR Scientific Assembly. Held 14-22 July 2018, in Pasadena, California, USA, Abstract id. PSD.1-18-18.

Pub Date:
July 2018

Bibcode:
2018cosp...42E2582P