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Orbit Determination and Propagation (9)

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ON THE GAUSSIANITY VALIDITY TIME FOR ORBITAL UNCERTAINTY PROPAGATION

Abstract

Most of the algorithms and methods used in the eld of Space Surveillance and Tracking (SST) assume that the orbital uncertainty of space objects is accurately described by a multivariate Gaussian (normal) distribution. However, it is well-known that being the space dynamics highly non-linear (especially in a Cartesian representation of the orbital state vector), the normal distribution assumption does not hold for a long time in the absence of new information/measurements. This paper aims to quantify this long time by means of Multivariate Normal (MVN) statistical tests applied to Monte Carlo simulations. Moreover, an analytical method is proposed for determining the departure from Gaussianity that consists in monitoring the distance between the uncertainty distribution propagated by linear and non-linear techniques. Monte Carlo and analytical approaches are compared showing a good agreement. This provides an efcient method to assess the Gaussianity validity time of the propagation of orbital uncertainties. A direct application of this method is to use the Gaussianity validity time as a threshold in the splitting criterion for a Gaussian Mixture Model representation.