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Satellite Orbital Interpolation using Tchebychev Polynomials

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A satellite or artificial probe orbit is made of time series of orbital elements such as state vectors (position and velocities, keplerian orbital elements) given at regular or irregular time intervals. These time series are fitted to observations, so that differences between observations (distance, radial velocity) and the theoretical quantity be minimal, according to a statistical criterion, mostly based on the least-squared algorithm. These computations are carried out using dedicated software, such as the GINS used by GRGS, mainly at CNES Toulouse and Paris Observatory.
From an operational point of view, time series of orbital elements are 7-day long. Depending on the dynamical configurations, more generally, they can typically vary from a couple of days to some weeks. One of the fundamental parameters to be adjusted is the initial state vector. This can lead to time gaps, at the level of a few dozen of centimetres between the last point of a time series to the first one of the following data set.
The objective of this presentation consists in the improvement of an interpolation method freed itself of such possible “discontinuities” resulting between satellite’s orbit arcs when a new initial bulletin is adjusted. We compare solutions of different Satellite Laser Ranging using interpolation methods such as Lagrange polynomial, spline cubic, Tchebychev orthogonal polynomial and cubic Hermite polynomial. These polynomial coefficients are used to reconstruct and interpolate the satellite orbits without time gaps and discontinuities and requiring a weak memory size. In this approach, we have tested the orbital reconstruction using Tchebychev polynomial coefficients for the LAGEOS and Starlette satellites. In this presentation, it is showed that Tchebychev’s polynomial interpolation can achieve accuracy in the orbit reconstruction at the sub-centimetre level and allowing a gain of a factor 5 of memory size of the satellite orbit with respect to the Cartesian coordinates’ representation.