Derivative-free high-order methods applied to preliminary orbit determination *

Francisco Chicharro, Alicia Cordero, Juan R. Torregrosa
Instituto de Matemática Multidisciplinar
Universitat Politècnica de València,
vicarmar@teleco.upv.es / acordero@mat.upv.es / jrtorre@mat.upv.es

From position and velocity coordinates for several given instants, it is possible to determine orbital elements for the preliminary orbit. This theoretical trajectory, also known as keplerian orbit, is defined taking only into account mutual gravitational attraction forces between both bodies, the Earth and the satellite. Nevertheless it should be refined with later observations from ground stations, whose geographic coordinates are previously known.

Different methods have been developed for this purpose (see [1]), constituting a fundamental element in navigation control, tracking and supervision of artificial satellites. Most of these methods need, in their process, to find a solution of a nonlinear function. In classical methods it is usual to employ fixed point or secant methods. The later case is often used when it is not possible to obtain de derivative of the nonlinear function. Nowadays, there exist efficient numerical methods that are able to highly improve the results obtained by the classical schemes.

We will focus our attention in the method of iteration of the true anomaly, in which the secant method is replaced by more efficient methods, as the second-order Steffensen's method (see [2]), as well as other high-order derivative-free methods [3, 4]. In all cases, we analyze the efficiency of the resulting modified true anomaly method, in terms of precision, convergence and range of the effectiveness taking into account the spread of the observations used.

References

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