Global Error Control in Nonlinear Kalman Filtering Algorithms

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The new *Accurate Continuous-Discrete Extended Kalman Filter* based on the combined use of the embedded Runge-Kutta pair `NIRK4(2)` (or `NIRK6(4)`) with global error control [1] and Mazzoni's scheme [2] is discussed, here. More precisely, the state expectation equation is solved by the `NIRK4(2)` (or `NIRK6(4)`) method with global error control because only this equation may be nonlinear and, hence, create more difficulty for the accurate numerical solution. On the other hand, the error covariance matrix equation is treated by the corresponding part of Mazzoni's scheme. We also do not calculate and control the error of the numerical scheme applied to this matrix differential equation because of its linearity. All this saves the execution time of the codes, considerably. To increase the accuracy and robustness of our complex computational technique for a finite-precision computer arithmetics, we develop the square-root variant of the designed hybrid ODE solver with the global error control. Then, we examine it in severe conditions of tackling a seven-dimensional radar tracking problem, where an aircraft executes a coordinated turn. The latter is considered to be a challenging one for testing nonlinear filtering algorithms. Our numerical results confirm that the presented technique is flexible and robust. It treats successfully (and without any additional tuning) the target tracking problem for various initial data and for a range of sampling times. A numerical comparison to other effective filters as the continuous-discrete cubature and unscented Kalman filters is also provided.

References

[1] G. YU. KULIKOV, *Cheap global error estimation in some Runge-Kutta pairs*, IMA J. Numer. Anal., 33 (2013), pp. 136–163.

[2] T. MAZZONI, *Computational aspects of continuous-disrete extended Kalman filtering*, Computational Statistics, 23 (2008), pp. 519-539.