AE4872 (2017) – SATELLITE ORBIT DETERMINATION

Assignment 4 – Kalman Filter

Instructor
Dr.ir. Wouter van der Wal
w.vanderwal@tudelft.nl
office: 9.02
phone: 015-2782086

Group Size: 1 or 2 Students
Due: 13:30h, Monday 23 October, 2017

An electronic copy of the report should be submitted through Turnitin on Brightspace. Overdue submission will cause reduction of the lab grade by 20% per day after all GRACE days are used. It is preferred that you use MATLAB. Text as well as code should be your own work. Page limit of the report is 8 pages, including everything except the appendix with the code.

In the previous assignment you estimated the position of one of the SWARM satellites with only observations (assignment 2) and you estimated the initial state vector with one two dynamic parameter (assignment 3). In this assignment the same data is used but now applied in a Kalman filter, which gives you more control over how to combine measurements and the dynamic model.

(points: 100/100)

a) Compute the position of the SWARM A satellite at 10 epochs using the extended Kalman filter (see section 10.3.5 of the lecture notes for the ordinary Kalman filter and see the video for the extended Kalman filter). In the extended Kalman filter the propated state is used as the reference. Use Euler integration to propagate the state vector (as in assignment 3) and use the propagated state vector to compute the observation vector and the design matrix.
Compare the estimated radial distance of the SWARM satellite with that of the precise orbit. Use the receiver clock correction you estimated in Assignment 2. As initial conditions you can use the results of Assignment 2, but modify them to make the convergence of the extended Kalman filter visible. Diagonal matrices can be used for the covariance matrices for the initial state vector and the observations. Explain in the report which values you put on the diagonals. **(35)**
b) Possibly convergence to the true solution is not reached in a). Show the effect of adding system noise and explain what is a good value of system noise. (**15**)

c) Show the effect (if any) of putting more weight on the initial state vector and explain the results. (**10**)

d) Show the effect (if any) of putting more weight on the observations and explain the results. (**10**)

e) Show the effect of using the numerical integration routine instead of the state transition matrix to propagate the state vector. Integrate the ordinary differential equation with the *ode* routine of MATLAB, using parameters set by the *odeset* routine (see section 2.2.2 in the lecture notes). To propagate the state covariance matrix you can still use the state transition matrix. Explain the change (if any) in results that you observe. (**20**)

f) The Kalman filter gives a good solution after a few time steps. Explain how you could get a good estimate for the first few epochs using the Kalman filter **(10).**