

## Assignment 7

### Development of optimal smoothing to increase the estimation accuracy

Performance – Friday, October 11, 2019  
Due to submit a performance report – Tuesday, October 15, 2019

The objective of this laboratory work is to develop algorithms to improve Kalman filter estimates, that is of prime importance for many practical control and forecasting problems. This will bring about a deeper understanding of main difficulties of practical Kalman filter implementation and skills to overcome these difficulties to get optimal assimilation output.

This laboratory work is performed in the class by students as in teams of 3-4 on October 11, 2019 and the team will submit one document reporting about the performance till October 15, 2019. Within your group, you may discuss all issues openly, and discuss and debate until you reach a consensus.

***Here is the recommended procedure:***

1. Reminder

Smoothing procedure is performed in backward in time and is applied to forward Kalman filter estimates. Smoothing takes into account both current and future measurements and therefore provides improved estimation compared to Kalman filter.

2. The trajectory of a moving object is disturbed by normally distributed unbiased random acceleration  $a_i$  with variance  $\sigma_a^2 = 0.2^2$ . All other conditions are the same as in Lab 5. Develop forward Kalman filter algorithm.

3. Develop backward smoothing algorithm to get improved estimates of state vector  $X_i$

*Hint*

The recurrent algorithm of smoothing is presented on charts Topic\_3\_Optimal approximation at state space.pdf, page 52.

4. Make  $M = 500$  runs of smoothing and compare true estimation error with errors of smoothing  $P_{i,N}$  provided by smoothing algorithm.

- (a) error of smoothed estimates of coordinate  $x_i$ ;
- (b) error of smoothed estimates of velocity  $V_i$ ;

5. Compare smoothing errors of estimation with filtration errors of estimation.

6. Make conclusions to the Assignment.

Conclusions should be done in a form of a learning log. **A learning log** is a journal which evidences your **own learning and skills development**. It is not just a diary or record of **“What you have done”** but a record of **what you have learnt, tried and critically reflected upon**.

7. Prepare performance report and submit to Canvas:

Performance report should include 2 documents:

- 1) A report (PDF) with performance of all the items listed above
- 2) Code (PDF)

**Notes:**

- PDF report should contain the names of team members, number of the assignment
- All questions of the assignment should be addressed
- All figures should have a caption, all axes should have labels, a legend to curves should be given, and short conclusions/discussions/results related to figures should be provided.
- The overall conclusion to the assignment should be provided in a form of a learning log.