**Laboratory work 12**

**Joint assimilation of navigation data coming from different sources**

Performance - Friday, May 13, 2016

Due to submit a performance report – Wednesday, May 18, 2016

The objective of this laboratory work is to develop a navigation filter by assimilating data coming from different sources. Important outcome of this exercise is getting skill to incorporate all available measurement information into assimilation algorithm and develop a tracking filter for nonlinear models.

This laboratory work is performed in the class by students as in teams of 2 on May 13, 2016 and the team will submit one document reporting about the performance till May 18, 2016. Within your group, you may discuss all issues openly, and discuss and debate until you reach a consensus.

1. ***Here is the recommended procedure:***Generate a true trajectory of an object motion disturbed by normally distributed random acceleration

***Initial conditions to generate trajectory***

1. Size of trajectory is points.
2. seconds – time step.
3. Initial coordinates

1. Initial components of velocity
2. Variance of noise , for both
3. Generate also true values of range and azimuth
4. Generate measurements of and of range and azimuth provided by first observer that arrive every 4 seconds.

– **odd** time steps

Variances of measurement noises are given by

;

1. Generate more accurate measurements of azimuth provided by second observer that arrive between measurement times of the first observer.

– **even** time steps

Variance of measurement noise in this case is given by

1. Initial conditions for Extended Kalman filter algorithm  
   Initial filtered estimate of state vector

Initial filtration error covariance matrix

First use great initial filtration error covariance matrix

1. Develop Kalman filter algorithm to estimate state vector (extrapolation and filtration).

**Start algorithm from time step = 4.**

* 1. At every filtration step depending on observer, measurement vector and observation function have different form.

Consult charts, pages 3 – 6, Lab12\_Brief\_explanations.pdf.

* 1. The form of measurement noise covariance matrix also varies:

1. Observer 1, odd time steps
2. Observer 2, even time steps
   1. Using extrapolated and filtered estimates at every extrapolation and filtration step you will need to calculate
3. range
4. azimuth
   1. At every filtration step in the algorithm you should linearize measurement equation by determining

Consult charts, pages 3 – 6, Lab12\_Brief\_explanations.pdf.

1. Run Kalman filter algorithm over runs.

Calculate true estimation errors of

1. Errors of extrapolation and filtration estimates of range
2. Errors of extrapolation and filtration estimates of azimuth

Please plot these errors on two different plots for the analysis.

1. Compare estimation results with measurement errors of and .
2. Analyze again estimation errors of range and azimuth .  
   Please make conclusions why the accuracy of estimation varies for odd and even time steps for both and .

***Performance report***

1. Performance report should contain all the items listed
2. The code should be commented. It should include:

* Title of the laboratory work, for example

% Converting a physical distance to a grid distance using least-square method

* The names of a team, indication of Skoltech, and date, for example,   
  %Tatiana Podladchikova, Skoltech, 2016

Main procedures also should be commented, for example

%13-month running mean

…here comes the code

1. If your report includes a plot, then it should contain: title, title of x axis, title of y axis, legend of lines on plot.