TTK4250 Sensor Fusion

Graded Assignment 1 - Code Report

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- We based our tuning parameters' starting point from assignment 3 and 4, as we assume them to be approximating the covariances related to actual boat maneuvers, and sensor noise.
- The tuning process was then was very manual, where we changed one parameter at a time, and then analyzed whether position and velocity estimate errors were consistent, and whether the RMSE values were lower for a given tuning parameter value. Max deviation in position and velocity were not considered important in order to simplify the tuning process, although this could have practical implications. We considered error in turn-rate estimation not important for target tracking purpose.
- This manual process could maybe be simplified by brute-forcing through the different tuning parameters as we did for covariance values in assigment 2 with EKF. A better alternative is to maybe define this as an optimization problem and solve, which was not further investigated due to time limitation.
- In addition to looking at the RMSE and constistency, we made sure as well that our filter had very clear mode change/transistion when it switched between different models during turn maneuvers and straight line CV paths.
- We approximated the total number of measurements per timestep to find a relation between λ and PD to reduce a degree of freedom during tuning

$$E[m_k] = \lambda V + P_D \approx \frac{1}{K}\sum_{k=1}^{K} m_k \tag{1}$$

  where K is total number of timesteps, m_k is number of measurements for each timestep, λ is the clutter rate, V_k is the total volume and P_D is the probability for detection of the target.

- At the end of the tuning process, we realized that no missed detections means high detection probability, and so we tried with very high $P_D = 0.95$, and this resulted in impressive consistency values and low RMSE values. The results can be seen in fig:fig1 marked in red.

INPUT							OUTPUT				
qCV	qCT1	qCT2	r	PD	Lamda	gateSize	posRMSE	velRMSE	posConstistency	velConstistency	Comments
0.05	*0.005*	*0.000025*	*5*	*0.8*	*1.00E-03*	*25*	*4.923*	*0.898*	*89*	*92*	*Baseline*
0.05	0.005	0.000025	5	0.8	**1.00E-04**	25	2.59	0.758	93	92	Better overall
0.05	0.005	0.000025	5	**0.85**	9.85E-05	25	2.519	0.745	91	92	Better posRMSE, consistent
0.05	0.005	0.000025	5	0.85	9.85E-05	**100**	2.519	0.745	91	92	Same as above, so bad
0.05	0.005	0.000025	5	0.85	9.85E-05	**9**	2.705	0.768	89	93	Poor performance overall with smaller gatesize
0.05	0.005	0.000025	**3**	0.85	9.85E-05	25	2.659	0.775	89	93	Worse compared to r=5
0.05	0.005	0.000025	**6**	0.85	9.85E-05	25	2.504	0.742	90	91	Better posRMSE, stil consistent
0.01	0.005	0.000025	6	0.85	9.85E-05	25	2.606	0.756	87	82	Bad consistency and RMSE
0.07	0.005	0.000025	6	0.85	9.85E-05	25	2.503	0.741	90	88	velocity not consistent
0.06	0.005	0.000025	6	0.85	9.85E-05	25	2.503	0.742	90	89	velocity not consistent, keep r=0.05
0.05	**0.01**	0.000025	6	0.85	9.85E-05	25	2.514	0.743	92	89	velocity not consistent
0.05	**0.001**	0.000025	6	0.85	9.85E-05	25	2.504	0.744	89	91	position not consistent
0.05	0.005	**0.00025**	6	0.85	9.85E-05	25	2.472	0.735	87	91	position not consistent
0.05	0.005	**0.0000025**	6	0.85	9.85E-05	25	2.616	0.791	91	84	bad overall
0.05	0.005	**0.00003**	6	0.85	9.85E-05	25	2.499	0.741	89	91	bad pos consitency
0.05	0.005	**0.00002**	6	0.85	9.85E-05	25	2.512	0.745	90	90	worse than our best candidate
0.05	0.005	0.000025	6	0.85	9.85E-05	25	2.504	0.742	90	91	
0.05	0.005	0.000025	6	**0.95**	9.82E-05	25	2.432	0.724	90	92	

Figure 1: Screenshot of tuning IMMPDAF parameters and commenting

Final parameters: $qCV = 0.05$, $qCT1 = 0.005$, $qCT2 = 0.000025$, $r = 6$, $P_D = 0.95$ and $\lambda = 9.825e-5$.