SSY191 - Sensor Fusion and Nonlinear Filtering
Peer-Review of Home Assignment 03

Lucas Rath

1 Approximations of mean and covariance

A-D) Nice explanation. I know that it is just a detail, but I think I would not say that the first distribution is Gaussian. Instead I would say it is very similar to a Gaussian distribution. The point is that, for this non-linear transformation the output will never be Gaussian. However, as you said, there are regions where this function behaves well. In this case, it behaves well around $\hat{x}_1$.

E) I totally agree with your analysis in this item. However, I think that there are other methods that can handle very non-linear distribution much better than non-linear Kalman filters and they do not need infinitely many moments to describe the distribution. One example is the particle-filter. Therefore, in my opinion, is not a good idea to use these methods when the motion or measurement models are too non-linear.

2 Non-linear Kalman filtering

B) Your explanation is very concise. I just fell a bit confused when you say that the poor performance of the filters are due to big changes in the trajectory and then you relate this to the non-linearity of the function. Wouldn't that be a problem of the way we have tuned the filter? I am not sure if I would correlate high-accelerations in the true trajectory to non-linearities, because this depends on the noise right? One model might have high accelerations and still be linear. The filter might perform really bad if we do not tune it well.

I would also add that the major axis of all sigma-ellipses are pointing towards the sensor 1, which is the sensor with less covariance noise. This is reasonable right?

C) At first sight I agree that all distributions look Gaussian. However, you could have calculated the mean and covariance of the errors and plot a normalized Gaussian from these parameters. You would see that the distributions are not Gaussian at all. The problem is that there are too many samples far away from the mean and then we get a very large covariance that does not match with the histograms.

3 Tuning non-linear filters

A) Nice analysis

B-C) Nice explanation. I think you could have mentioned about the transition straight line - curve and vice-versa. If you set the model covariances too low you will get nice filtering when the vehicle moves steady in the straight line or in the curve but it would fail to detect accelerations in the true state. If you set the covariances too high, you catch nicely the transitions (accelerations in position and yaw) but then you trust too much the measurements, which are very noisy, and we do not get a nice filter.

As a suggestion, try to use `axis equal`. It will scale the axis equally and it will be easier to interpret the data.

D) I think you forgot question D :(

I think you did a great job. I hope you get full points :)