Question 1-1

In the covariance form the distribution is:

We develop the matrix multiplication inside into:

Since all this in exponential, we can split them, taking the term not dependent on x outside, so that we get:

Now, by knowing that we can replace the symbols in the equation and get:

Question 1-2

Given:

Initial belief:

1. The prior p(x) is the mere Normal distribution with known mean and covariance

The measurement likelihood p(z|x) will also be Gaussian, since error is present. With mean in h(x):

1. Measurement z1 acquired. Posterior probability is given by the Bayes Rule:
2. – derive expressions for this to hold for

We’re about to find the MAP estimate for .

To reach the minimum we have to seek for the case there both of those term will be equal zero. is nonlinear, we have to linearize it around , hence

so we can rewrite

Collecting the Jacobian matrix together we get the equation system:

Where

Matrix A is 2X1, not invertible, so that for calculation we perform:

By calculating the we update the by adding it to .

**(d)** Using the Markov assumption we can write:

Where the expression for was found in (c). And expression for is obtained from regular observation model. So we get:

By multiplying 2 Normal Distributions we get a Normal distribution with its own and .

Question 1-3

Given a state transition model:

And regular observation model:

1. Expression for the motion model:

The covariance for is derived:

Hence, the distribution is normal with the derived covariance:

Or

**(b)** from the Bayes Rule:

Expanding:

So that together we get:

Where:

**(c)** denote a general form: (using (b))

Expanding the distribution forms (leaving the constant behind):

To turn the problem into least squares, perform the log on the argmax expression:

It can be seen that we’re got the non-linear least squares problem.

**(d)** We are given the covariance matrix . We can observe that to marginalize we only need the covariance member which is responsible for the covariance out of it, which means:

To get the information form marginalization more operations are performed: (from the lecture slide)