* UKF (Ref: [1]

1. Review
   1. Non-linear Filtering
2. Problem :

Let is a Gaussian random variable, i.e.,   
 A second random variable is related to through the nonlinear function

Find

1. Approximated solution : Unscented transform
2. Find Sigma points

where

1. Find the UT mean and variance of

Then the mean is

And the covariance of

1. UT Kalman Filter
   1. Problem

**Construct a UT Kalman filter**

* 1. Predict Step

1. Define Sigma Points with weighting function

where

1. Prediction (UT transform)

Calculate the mean and the variance of the non-linear transform at each “sigma points” as

1. Correction step (UT transform)

Here the measurement is so that

Calculate the mean and the variance of the measurement

1. Kalman Gain

First find the cross variance

Then The Kalman gain is

And the correction

and its covariance is

%%% Kim’s comment

1. First we should find the sigma points of
2. There are two non-linear transformation, we should get as
3. In this procedure, every mean and the covariance is approximated, however , they are a good approximation.

%%%

* Kalman / Unscented Filter compariosn

|  |  |  |
| --- | --- | --- |
|  | Kalman Filter | Unscented |
| Generate  Sigma Points |  |  |
| Predic  tion |  |  |
| Correc  tion |  |  |

[1]” Kalman and Bayesian Filters in Python”, ch.10

Why random and stochastic process?

1. Real world is in random
   1. Linear system
2. Kalman Controller (LQR) :
3. Kalman state estimator (Kalman filter)

the estimator is needed:

* 1. Non-linear system

i.e.

1. Linearize : see 1.1)
2. Non-linear filtering:

then

So the estimator is needed as

1. Model Uncertainty / unknown
   1. Model Uncertainty

Consider

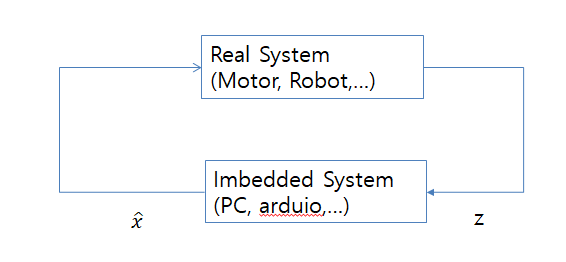
But your model as

In this case you may try as

* 1. Unknown

In the machine learning, or AI, in generally the model is unknown. In this case, the model may be defined as you want (supervised learning) with the additive noise so that the error between data and the model should be minimized. Here you may use to assess the to be minimized.

1. Remember



The imbedded system is designed as YOU want !! The criteria is the performance of the total system,i.e., with “Real System”.

Hence it is necessary to include the real systems dynamics(in general , non-linear system) in simulation.