1. The extended Kalman filter

%%% Kim’s comment : Non-linear Estimation

For non-linear system, to estimate parameters is totally dependent of the considering system. The way to find “Optimal” estimator is not unique.

There are several methods

-. Non-linear least square method. This is the basic and popular in the control society. It was already proposed and to solve some problems, See Excersize 4.8, by Gauss. He solved using the batch type LSE. For the recursive, or real time type, it was introduced 1970 by Jazwinski , so called Extended kalman filter, EKF, after kalman introduction for linear system 1960.

-. Unscented Kalman filter: around 1990, English engineers Julier introduce a brilliant idea different from EKF.

-. Particle Filters, which is totally dependent of Monte Carlo simulation, was introduced around 2000. It is goof for ‘Robotic Localization’, ‘Automatic Car driving ‘ and so on.

%%%

%%% Kim’s comments : non linearity

Consider a non-linear differential equation

1. The stationary points

The points so that implies the trajectory is stationary at that point. Hence

1. At the stationary points, find the nominal solution.

Taylor series:

For a small perturbation around a, the taylor series of is at the stationary points

Hence the differential equation (1) can be approximated near the stationary points. For example, at the stationary point “a = 0” a small perturbation

And the left hand side

Combining together,

which is a linear differential equation with respect to , since ,

gives the solution as

In conclusion near , x(t) converges to x(t) = 0

%%%

%%% HW Week\_8

1. How about the other stationary points?
2. At the initial point draw the trajectory.
3. At the initial point , draw the trajectory. %%%

Here I want to talk about non-linear least square estimation method. Remember at

at Chapter 4.4 about “Non-linear Square Estimation”, which is the batch type. In this chapter, I will consider it with recursive Non-linear Least Square estimation.

* 1. Linearized Kalman filtering
     1. Continuous time theory
  2. The extended Kalman Filter

%%% Extended Kalman Filter in discrete version

<https://en.wikipedia.org/wiki/Extended_Kalman_filter#:~:text=In%20estimation%20theory%2C%20the%20extended,the%20current%20mean%20and%20covariance>.

* Modeling
* Predict(A priori)
* Update(Correction / Estimation)
* Innovation:
* (Near-Optimal) Kalman gain
* Update (A posteriori)

Here

1. It is suboptimal
2. The gain formula equation is different from the previous ones(last semester) but the result is same %%%
3. This formulae is referred as the extended Kalman filter

|  |  |  |
| --- | --- | --- |
|  | Linear Model | Non Linear Model |
| Model |  |  |
| Prediction  (A posteriori) |  |  |
| (A priori) |  |  |