Tracking Systems
Extended Kalman Filter

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ECE 854
Lab 5 Report

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1 Introduction

This lab deals with application of the Extended Kalman filter to track the position of a object. The report starts with describing the system, building the EK filter equations and discussing the results of the tracking objective.

2 Implementation

The implementations of the Extended Kalman filter to this system is considered.

2.0.1 1D Tracking

The state space equations that describe the position and velocity of a 1D particle is given as

$$f(x_t + a_t) = \begin{bmatrix} x_{t+1} = x_t + \dot{x}_t T \\ \dot{x}_{t+1} = \dot{x}_t + a_t \\ h_{t+1} = \sin \frac{x_t}{10} \end{bmatrix} = X_{t,t-1} \tag{1}$$

The parameter h_t models the movement of the sine wave.

Constructing the equations for the EK filter using the above equations we are able to track the position of the particle. The tracking is below.

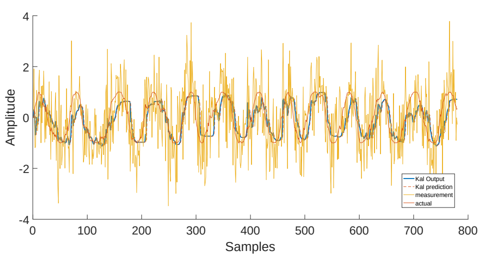

Figure 1: EKF Tracking

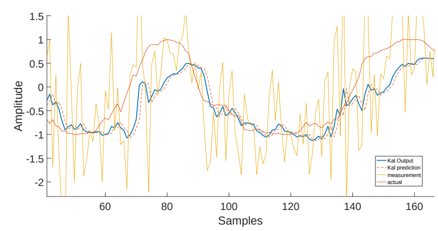

Figure 2: Zoom of EKF Tracking

Fig 7 shows that the output of the EK filter. A clearer zoom is shown in Fig 8. These graphs were obtained for

$$Q = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0.0001 & 0 \\ 0 & 0 & 0 \end{bmatrix}, nt = 0.1$$

3 Results

The variations in Q and R yield these different results.

3.1 Case 1

$$Q = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0.001 & 0 \\ 0 & 0 & 0 \end{bmatrix}, R = 0.5$$

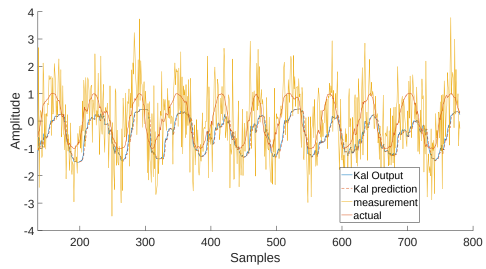

Figure 3: EKF Tracking case 1

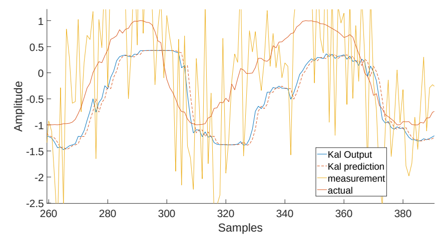

Figure 4: Zoom of EKF Tracking case 1

Here we can see that the output tries to follow the predictions then the measurements.

3.2 Case 2

$$Q = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0.001 & 0 \\ 0 & 0 & 0 \end{bmatrix}, R = 0.1$$

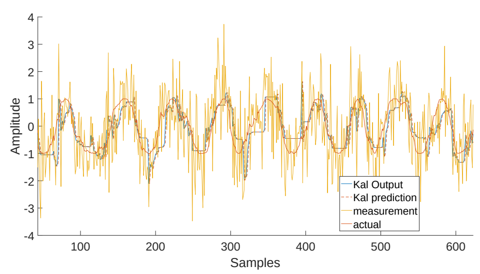

Figure 5: EKF Tracking case 2

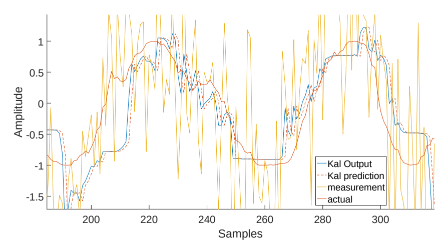

Figure 6: Zoom of EKF Tracking case 2

This seems as the best combination of Q and nt to fit the data.

3.3 Case 3

$$Q = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0.001 & 0 \\ 0 & 0 & 0 \end{bmatrix}, R = 0.01$$

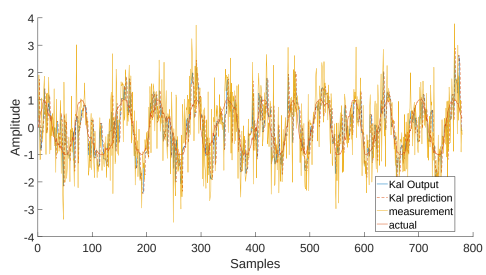

Figure 7: EKF Tracking case 3

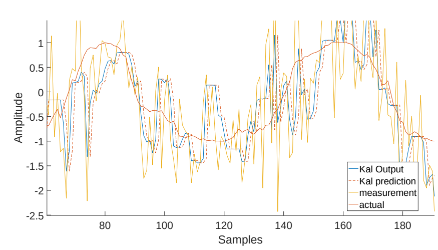

Figure 8: Zoom of EKF Tracking case 3

Here we can see that the output tries to follow the Measurements more closely.