Homework 4 - RIDF Analysis

Jose Eduardo Laruta Espejo
Facultad de Ingeniería - Universidad Mayor de San Andrés

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1 Tracker Model

In this case, we need to use the piece-wise linear characteristic of the ideal limiter, from slide 20:

$$\phi(v) = \begin{cases} v & |v| \leq \delta \\ \delta sign(v) & |v| > \delta \end{cases} \tag{1}$$

$$\hat{\phi} = \sigma \left[G(\frac{\delta + m}{\sigma}) - G(\frac{\delta - m}{\sigma}) - 1 \right] - m \tag{2}$$

$$N_\phi = F(\frac{\delta + m}{\sigma}) - F(\frac{\delta - m}{\sigma}) - 1 \tag{3}$$

For the Matlab implementation is important to point out that the functions F and G have been implemented using anonymous functions inside de model function (lines 13 and 14). This is for the code being more readable.

Another global parameter was added corresponding the value of δ for the limit of the saturation model. In this case, for simulating a linear case we use the `Kant` global variable when it is equal to zero, then the values of $\hat{\phi}$ and N_ϕ are forced to te corresponding values for the linear model (lines 18-20).

```
1  function xdot = tracker_ridf_erf(t,x)
2  % RIDF m-dot P-dot model for antenna trackign problem
3  % this model uses a limiter model for the nonlinearity
4  % "states" are m1, m2m p11, p12, p22
5  A = 50;          % sec^{-1}
6  K = 10;          % sec^{-1}
7  global Kant      % global variable for k nl
8  global Delta     % global for delta
9  Omega = 5;       % deg/sec LOS angle rate
10 q = 0.004;         % dec^2
11 %% limiter term
12 % anonymous functions for F and G
13 F = @(v) (erf(v/sqrt(2)) + 1)/2;
14 G = @(v) v*F(v) + exp(-((v*v)/2))/sqrt(2*pi);
15 % quasilinear model
```

```
fhat = sqrt(x(3)) * (G((Delta + x(1))/sqrt(x(3))) - G((Delta - x(1))/sqrt(
   x(3)))) - x(1);
Nr = F((Delta + x(1))/sqrt(x(3))) - F((Delta - x(1))/sqrt(x(3))) - 1;
if Kant == 0              % if linear model is required
    fhat = x(1);
    Nr = 1;
end
xdot(1) = -K*x(2) + Omega;
xdot(2) = A*(fhat - x(2));
P = [ x(3) x(4); x(4) x(5) ];
% test P stays positive semi-definite
T1 = P(1,1); T2 = det(P);
if T1 < 0, error('P(1,1) negative - bummer!'); return; end
if T2 < 0, error('P negative-def. - bummer!'); return; end
NR = [0 -K; A*Nr -A];
Q = [0 0; 0 A*A*q];
Pdot = NR*P + P*(NR') + Q;
xdot(3) = Pdot(1,1);
xdot(4) = (Pdot(1,2) + Pdot(2,1))/2;    % p simmetric
xdot(5) = Pdot(2,2);
xdot = xdot(:);
```

2 RIDF Analysis

Using the same initial conditions and parameters given for the problem in the slides, we can simulate the three models: linear, RIDF for cubic nonlinearity and RIDF for piece-wise linear saturation. The results can be seen in Fig

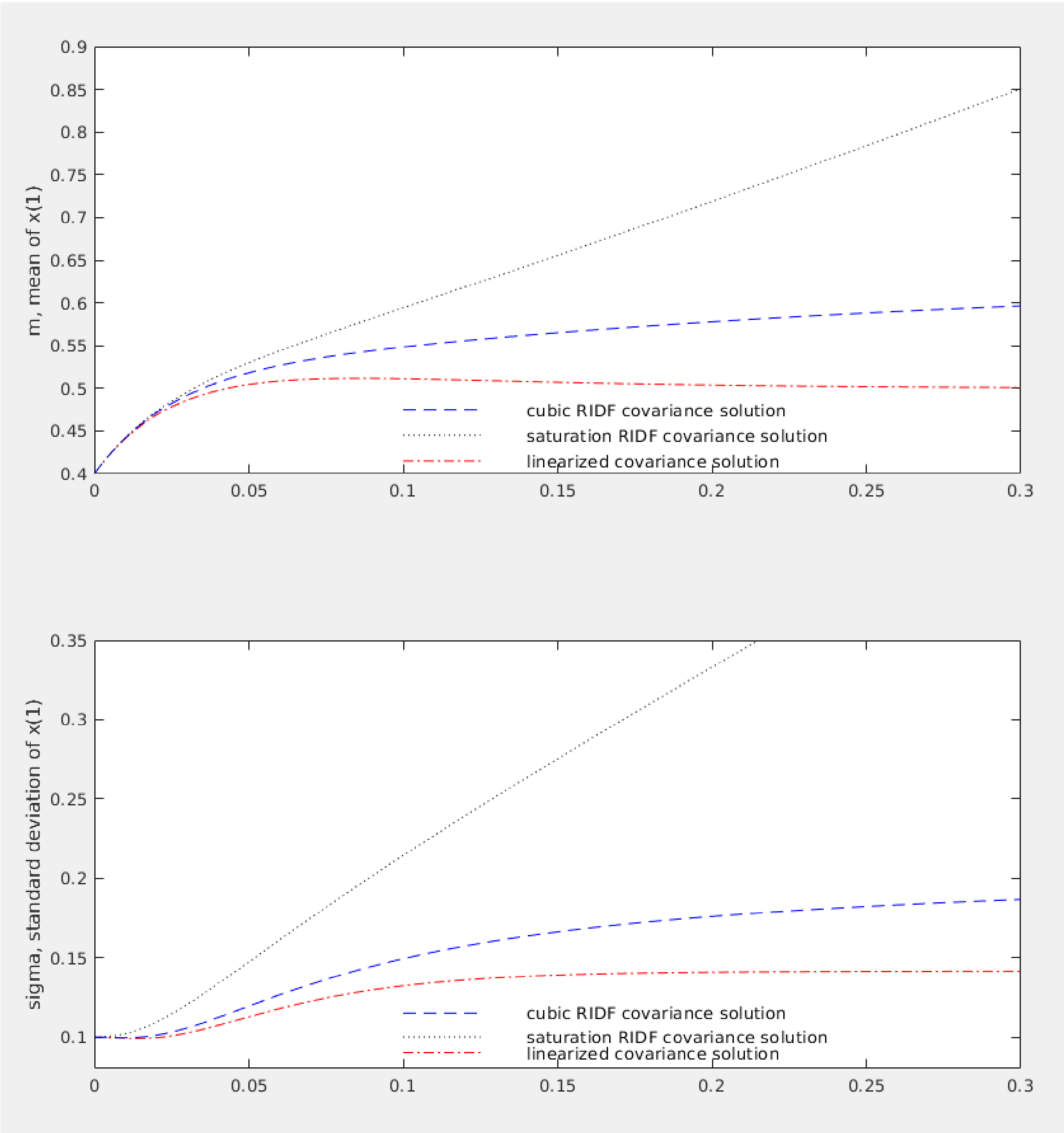

Figure 1: Covariance Analysis of the three models