Contents

AERO 626 Homework #2

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```
data = load('data_HW02.mat');
format long

% DATA PROVIDED ARE:
% T = (m x 1) array of measurement times [s]
% Z = (m x 1) array of position measurements [m]
% W = (m x 1) array of measurement weights [nd]
% R = (m x 1) array of measurement noise covariances [m^2]
```

Part A: Least-Squares Estimate of State

```
F = [0 1; -1 0];
H_tilde = [1 0];
H = [];
for i = 1:length(data.T)
    Phi_i = expm(F*(data.T(i) - data.T(1)));
    H_i = H_tilde*Phi_i;
    H = [H; H_i];
end
disp('Least-Squares Estimate of Initial State using matrix exponential for Phi:')
x_hat_0 = (H'*H)\(H'*data.Z)

H = [];
for i = 1:length(data.T)
    t_i = data.T(i);
    Phi_i = [cos(t_i) sin(t_i); -sin(t_i) cos(t_i)];
    H_i = H_tilde*Phi_i;
    H = [H; H_i];
end
disp('Least-Squares Estimate of Initial State using analytical solution for Phi:')
x_hat_0 = (H'*H)\(H'*data.Z)
```

```
Least-Squares Estimate of Initial State using matrix exponential for Phi:

x_hat_0 =

   1.001143323295085
  -0.005513909940539

Least-Squares Estimate of Initial State using analytical solution for Phi:
```

```
x_hat_0 =

   1.001143323295085
  -0.005513909940539
```

Part B: Weighted Least-Squares Estimate of State

```
W = diag(data.W);
disp('Weighted Least-Squares Estimate of Initial State:')
x_hat_0 = (H'*W*H)\(H'*W*data.Z)
```

```
Weighted Least-Squares Estimate of Initial State:

x_hat_0 =

   1.004569504535051
  -0.007651308799164
```

Part C: Weighted Least-Squares Estimate with prior information

```
x_bar = [1; 0];
W_bar = [3 0; 0 3];
disp('Weighted Least-Squares Estimate of Initial State using prior info:')
x_hat_0 = (H'*W*H + W_bar)\(H'*W*data.Z + W_bar*x_bar)
```

```
Weighted Least-Squares Estimate of Initial State using prior info:

x_hat_0 =

   1.004375010528215
  -0.007340452622603
```

Part D: LUMVE of State

```
disp('LUMVE of Initial State:')
P_vv = diag(data.R);
x_hat_0 = (H'*P_vv^-1*H)\(H'*P_vv^-1*data.Z)
disp('The uncertainty in our measurement can be evaluated using the covariance matrix of the estimate:')
cov_matrix = (H'*P_vv^-1*H)^-1
```

```
LUMVE of Initial State:

x_hat_0 =

   1.001143323295085
  -0.005513909940539
```

```
The uncertainty in our measurement can be evaluated using the covariance matrix of the estimate:

cov_matrix =

   1.0e-03 *

   0.188443928965983  -0.006703912786495
  -0.006703912786495   0.209123502754448
```

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