Identificarea Sistemelor LABORATOR 3

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PROBLEMA 1 (MCMMP pentru modele ARX): 4A,4B,4C,4D

```
% A - ARX[1,1] - intrare u
at = [-0.8]; %Coeficientul lui q^-1 pentru polinomul A(q^-1) de ord I
                     %Coeficientul lui q^{-1} pentru polinomul B(q^{-1}) de ord I
bt = [1];
K = [50];
N = [1000];
nr = [1000];
ISLAB_4A(at, bt, K, N, nr);
                                             Estimating an ARX[1,1] model by the Least Squares Method
                                                                                                           estimation error
               0.4
                                                                                                           standard deviation tube
            ER magnitude
0 02-0-2
              -0.4
                                                         Normalized frequency [rad/s] (log)
                                                                                                           estimation error
             phase [deg]
             FR
                10<sup>-2</sup>
                                                    10<sup>-1</sup>
                                                                                       10<sup>0</sup>
                                                                                                                          10
                                                         Normalized frequency [rad/s] (log)
                                             Estimating an ARX[1,1] model by the Least Squares Method
                                True parameters: -0.8000 1.0000
            Noise variance
               0.8
              0.7
               0.6
                           100
                                     200
                                                300
                                                           400
                                                                     500
                                                                                600
                                                                                           700
                                                                                                     800
                                                                                                                900
                                                                                                                          1000
                                                                Realization index
```

Fig 1. Graficele pentru 4A (ARX[1,1], intrare nefiltrata)

Fig 2. Graficele pentru 4B (ARX[1,1], intrare filtrata)

0.6

```
% C - ARX[2,2] - intrare u
at = [-0.4 - 0.32]; %Coef lui q^-1 si q^-2 pentru polinomul A(q^-1) de ord II
bt = [0.5 \ 0.03]; %Coef lui q^-1 si q^-2 pentru polinomul B(q^-1) de ord II
K = [50];
N = [1000];
nr = [1000];
ISLAB_4C(at, bt, K, N, nr);
                                               Estimating an ARX[2,2] model by the Least Squares Method.
                                                                                                                 estimation error
               0.2

    standard deviation tube

            FR magnitude
               0.1
               -0.1
               -0.2
                                                      10<sup>-1</sup>
                                                                                                                                 10<sup>1</sup>
                                                            Normalized frequency [rad/s] (log)
                                                                                                                estimation error
standard deviation tube
              FR phase [deg]
                 10<sup>-2</sup>
                                                      10<sup>-1</sup>
                                                                                            10<sup>0</sup>
                                                                                                                                 10<sup>1</sup>
                                                            Normalized frequency [rad/s] (log)
                                               Estimating an ARX[2,2] model by the Least Squares Method
                                  True parameters: -0.4000 -0.3200 0.5000 0.0300
                              Estimated parameters: -0.3971 -0.3167 0.5000 0.0307
             Noise variance
               0.7
               0.5 L
                            100
                                       200
                                                   300
                                                              400
                                                                         500
                                                                                    600
                                                                                               700
                                                                                                          800
                                                                                                                      900
                                                                                                                                1000
```

Fig 3. Graficele pentru 4C (ARX[2,2], intrare nefiltrata)

```
% D - ARX[2,2] - intrare uf
at = [-0.4 - 0.32]; %Coef lui q^-1 si q^-2 pentru polinomul A(q^-1) de ord II
bt = [0.5 \ 0.03];
                               %Coef lui q^-1 si q^-2 pentru polinomul B(q^-1) de ord II
K = [50];
N = [1000];
nr = [1000];
ISLAB_4D(at, bt, K, N, nr);
               0.2
                                                                                                           standard deviation tube
            FR magnitude
              0.1
              -0.1
                10<sup>-2</sup>
                                                    10
                                                                                        10<sup>0</sup>
                                                                                                                           10<sup>1</sup>
                                                         Normalized frequency [rad/s] (log)
               10
                                                                                                           estimation error
                                                                                                           standard deviation tube
             FR phase [deg]
                -5
                                                    10<sup>-1</sup>
                                                         Normalized frequency [rad/s] (log)
                                             Estimating an ARX[2,2] model by the Least Squares Method.
               1.2
                                True parameters: -0.4000 -0.3200 0.5000 0.0300
                             Estimated parameters: -0.3978 -0.3169 0.5021 0.0321
                                                                                                                    true
            Noise variance
               0.8
               0.7
               0.6
```

Fig 4. Graficele pentru 4D (ARX[2,2], intrare filtrata)

Concluzii: Daca intrarea este filtrata, valorile estimate sunt mai putin precise, deoarece prin filtrare se reduce din informatie, astfel modelul este mai putin precis.

400

500

Realization index

600

700

900

1000

Se observa cum valorile estimate pentru parametrii sunt mai apropiate de valoarea reala atunci cand avem un ARX cu intrare nefiltrata.

Radacinile parazite ale lui ARX[2,2] pot fi estimate cu o intrare nefiltrata, insa destul de imprecis.

PROBLEMA 2 (MCMMP pentru modele OE): 4E,4F,4G,4H

```
% E - OE[1,1] - intrare u, eroare nefiltrata
at = [-0.8]; %Coeficientul lui q^-1 pentru polinomul A(q^-1) de ord I
bt = [1];
                      %Coeficientul lui q^-1 pentru polinomul B(q^-1) de ord I
K = [50];
N = [1000];
nr = [1000];
ISLAB_4E(at, bt, K, N, nr);
                                               Estimating an OE[1,1] model by the Least Squares Method
                                                                                                               estimation error
                                                                                                               standard deviation tube
              FR magnitude
                 10<sup>-2</sup>
                                                      10<sup>-1</sup>
                                                                                          10<sup>0</sup>
                                                                                                                               10<sup>1</sup>
                                                           Normalized frequency [rad/s] (log)
                                                                                                               estimation error
                                                                                                               standard deviation tube
            FR phase [deg]
               -30
                 10<sup>-2</sup>
                                                                                                                               10<sup>1</sup>
                                                      10<sup>-1</sup>
                                                           Normalized frequency [rad/s] (log)
                                               Estimating an OE[1,1] model by the Least Squares Method.
                                 True parameters: -0.8000 1.0000
                             Estimated parameters: -0.5853 0.9995
               1.3
               1.2
             Noise variance
               0.8
               0.7
```

500

Realization index

900

1000

Fig 5. Graficele pentru 4E (OE[1,1], intrare nefiltrata)

0.6

0.5

```
% F - OE[1,1] - intrare uf, eroare nefiltrata
at = [-0.8]; %Coeficientul lui q^-1 pentru polinomul A(q^-1) de ord I
                      %Coeficientul lui q^-1 pentru polinomul B(q^{-1}) de ord I
bt = [1];
K = [50];
N = [1000];
nr = [1000];
ISLAB_4F(at, bt, K, N, nr);
                                                Estimating an OE[1,1] model by the Least Squares Method.
                                                                                                                   estimation error
                                                                                                                  standard deviation tube
             FR magnitude
o
                 10<sup>-2</sup>
                                                                                             10<sup>0</sup>
                                                                                                                                   10<sup>1</sup>
                                                             Normalized frequency [rad/s] (log)
                                                                                                                  estimation error
standard deviation tube
             FR phase [deg]
                -10
               -15 L
10<sup>-2</sup>
                                                                                             10<sup>0</sup>
                                                                                                                                   10<sup>1</sup>
                                                       10<sup>-1</sup>
                                                             Normalized frequency [rad/s] (log)
                                                Estimating an OE[1,1] model by the Least Squares Method.
                                  True parameters: -0.8000 1.0000
                              Estimated parameters: -0.7059 1.2013
                1.3
             Noise variance
               0.8
               0.7
               0.6
               0.5 L
0
                             100
                                        200
                                                   300
                                                               400
                                                                          500
                                                                                                 700
                                                                                                            800
                                                                                                                       900
                                                                                                                                  1000
                                                                                     600
```

Fig 6. Graficele pentru 4F (OE[1,1], intrare filtrata)

```
% G - OE[2,2] - intrare u, eroare nefiltrata
at = [-0.4 - 0.32]; %Coef lui q^-1 si q^-2 pentru polinomul A(q^-1) de ord II
bt = [0.5 \ 0.03]; %Coef lui q^-1 si q^-2 pentru polinomul B(q^-1) de ord II
K = [50];
N = [1000];
nr = [1000];
ISLAB_4G(at, bt, K, N, nr);
                                               Estimating an OE[2,2] model by the Least Squares Method.
                                                                                                                estimation error
                                                                                                               standard deviation tube
             8.0
9.0
4.0
             <u></u> 0.2
                0
                 10<sup>-2</sup>
                                                      10<sup>-1</sup>
                                                                                           10<sup>0</sup>
                                                                                                                                10<sup>1</sup>
                                                           Normalized frequency [rad/s] (log)
                20
                                                                                                               estimation error
standard deviation tube
                10
            -20
                 10<sup>-2</sup>
                                                                                           10<sup>0</sup>
                                                      10<sup>-1</sup>
                                                                                                                                10<sup>1</sup>
                                                           Normalized frequency [rad/s] (log)
                                               Estimating an OE[2,2] model by the Least Squares Method.
                                 True parameters: -0.4000 -0.3200 0.5000 0.0300
               1.5
                              Estimated parameters: -0.1065 -0.1558 0.4987 0.1753
             Noise variance
               0.5
                  0
                            100
                                       200
                                                                        500
                                                                                              700
                                                                                                                    900
                                                                                                                               1000
                                                  300
                                                             400
                                                                                   600
                                                                                                         800
```

Fig 7. Graficele pentru 4G (OE[2,2], intrare nefiltrata)

```
% H - OE[2,2] - intrare uf, eroare nefiltrata
at = [-0.4 - 0.32]; %Coef lui q^-1 si q^-2 pentru polinomul A(q^-1) de ord II
bt = [0.5 \ 0.03];
                                %Coef lui q^-1 si q^-2 pentru polinomul B(q^-1) de ord II
K = [50];
N = [1000];
nr = [1000];
ISLAB_4H(at, bt, K, N, nr);
                                                Estimating an OE[2,2] model by the Least Squares Method
                                                                                                                 estimation error
                0.4

    standard deviation tub

            FR magnitude
0 0
2.0-
                                                       10<sup>-1</sup>
                                                                                            10<sup>0</sup>
                                                                                                                                 10<sup>1</sup>
                                                            Normalized frequency [rad/s] (log)
                60
                                                                                                                 estimation error
                                                                                                                 standard deviation tube
                40
             FR phase [deg]
                20
                -20
                 10<sup>-2</sup>
                                                       10<sup>-1</sup>
                                                                                            10<sup>0</sup>
                                                                                                                                 10<sup>1</sup>
                                                             Normalized frequency [rad/s] (log)
                                                Estimating an OE[2,2] model by the Least Squares Method.
                                  True parameters: -0.4000 -0.3200 0.5000 0.0300
                                                 -0.1878 -0.2433 0.4990 0.3254
                1.6
                1.4
             Noise variance
                0.6
                0.2
                                                                                                700
                  0
                             100
                                       200
                                                   300
                                                              400
                                                                         500
                                                                                    600
                                                                                                           800
                                                                                                                      900
                                                                                                                                 1000
```

Fig 8. Graficele pentru 4H (OE[2,2], intrare filtrata)

Concluzii: Asa cum s-a vazut si la ARX, daca avem o intrare filtrata performanta scade, deoarece se pierd din date.

Realization index

Standard deviation tube este mult mai ingust in cazul OE.

Insa se poate observa cum modelul OE prezinta o diferenta mai mare intre valorile estimate si cele reale decat in cazul ARX. Acest lucru este datorat faptului ca la OE eroarea nu este filtrata, astfel sistemul este supus la mai multe perturbatii.

PROBLEMA 3 (Generalizare): 41, 4J

```
% I - ARX[na, nb] - model generalizat ARX
at = [-0.4 - 0.32 - 0.2 - 0.54];
bt = [0.5 \ 0.03 \ 0.01 \ 0.2];
K = [50];
N = [1000];
nr = [100];
ISLAB_4I(at, bt, K, N, nr);
                                               Estimating an ARX[an,bn] model by the Least Squares Method.
                0.2
                                                                                                                     estimation error
                                                                                                                    standard deviation tub
             FR magnitude
0 0
                 10<sup>-2</sup>
                                                                                                                                     10<sup>1</sup>
                                                        10-
                                                              Normalized frequency [rad/s] (log)
                20
                                                                                                                     estimation error
             FR phase [deg]
                -10
                 10-2
                                                        10<sup>-1</sup>
                                                                                                                                     10<sup>1</sup>
                                                              Normalized frequency [rad/s] (log)
                                               Estimating an ARX[an,bn] model by the Least Squares Method
                                   True parameters: -0.4000 -0.3200 0.5000 0.0300
                               Estimated parameters: -0.3975 -0.3159 -0.0029 0.4934 0.0441 -0.0010
                1.2
              Noise variance
                0.6
                0.4
                0.2
```

Realization index

100

Fig 9. Graficele pentru 4I (ARX[na,nb])

10

```
% J - OE[na, nb] - model generalizat OE
at = [-0.4 - 0.32];
bt = [0.5 \ 0.03];
K = [50];
N = [1000];
nr = [100];
ISLAB_4J(at, bt, K, N, nr);
                                                    Estimating an OE[an,bn] model by the Least Squares Method
                                                                                                                              estimation error
standard deviation
              FR magnitude
                 0.2
                 -0.2
                   10<sup>-2</sup>
                                                             10<sup>-1</sup>
                                                                                                       10<sup>0</sup>
                                                                                                                                                10<sup>1</sup>
                                                                   Normalized frequency [rad/s] (log)
                                                                                                                              estimation error
                                                                                                                              standard deviation tube
              FR phase [deg]
                 -50
                                                                                                                                                10<sup>1</sup>
                                                                   Normalized frequency [rad/s] (log)
                                                    Estimating an OE[an,bn] model by the Least Squares Method.
                                      True parameters: -0.4000 -0.3200 0.5000 0.0300
                                 Estimated parameters: -0.1057 -0.1271 -0.1682 0.5043 0.1692 0.2851
                  1.3
                  1.2
               Noise variance
                 0.8
                 0.6
                 0.5
                 0.4 L
0
```

Fig 10. Graficele pentru 4J (OE[na,nb])

Concluzii: La problema 3 au fost generalizate modelele ARX si OE pentru nu numar mare de parametrii. Concluziile referitoare la precizia modelului sunt la fel ca la primele 2 probleme, intrucat avem tot modelele ARX si OE.

50

Realization index

100