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A Computer Program for Simulation of Multivariable Self-Tuning Regulators

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1976

Document Version:

Publisher's PDF, also known as Version of record

[Link to publication](#)

Citation for published version (APA):

Borisson, U. (1976). *A Computer Program for Simulation of Multivariable Self-Tuning Regulators*. (Technical Reports TFRT-7096). Department of Automatic Control, Lund Institute of Technology (LTH).

Total number of authors:

1

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A COMPUTER PROGRAM FOR SIMULATION OF
MULTIVARIABLE SELF-TUNING REGULATORS

U. BORISSON

Report 7615(C) March 1976
Department of Automatic Control
Lund Institute of Technology

A COMPUTER PROGRAM FOR SIMULATION OF MULTIVARIABLE SELF-TUNING REGULATORS

This report contains a listing of a simple computer program for simulation of multivariable self-tuning regulators. The results of the simulations are printed on line-printer, and they are also written in a file which can be plotted directly by IDPAC.

This version of the program is intended just for internal use. The program is started up on PDP15 as follows:

```
$ A NON 4,5,7,15,16
$ GLOAD
← STUREM,INDAM,PRIM,SYSM,STURM1,FILES
```

PROGRAM STUREM

SIMULATION OF SELF TUNING REGULATORS FOR MULTIVARIABLE SYSTEMS

AUTHOR: ULF BORISSON 1973-11-20

SUBROUTINES REQUIRED

INDAM

PRIM

SYSM

STURM1

FILES (in the program library)

COMMON YM(4,7),YSM(4,7),UM(4,10),EM(4,5),PM(16,16,4),TM(16,4),
2 NA(4),NB(4),BO(4),KSYS(4),KREG(4),ASYS(4,4,4),BSYS(4,4,4),
3 CSYS(4,4,4),N,NP,
4 EVEC(4),COV(4,4),ILOG,MNOD,MAC0,MAC,NABMAX,PDIAG,YSUM,
5 RL,ULIM,NSAMP,IP1,IP2,ICONT,ICOUN,
6 IP,IY,IU,IE,IPM,ITM,IABC,ICONS,JCONS(9,4),
7 FNAMA,FNAMB,W(20),BUFF(32),KOD(10),ITAPE,IPOIN

IP=4
IY=7
IU=10
IE=5
IPM=16
ITM=16
IABC=4

IN THIS VERSION IP AND IU ARE USED IN STURM1

CALL INDAM(1)

CALL PRIM(1)

IF (ITAPE .EQ. 0) GO TO 30

KOD(2)=2*NABMAX+1

KOD(7)=1

CALL FILES('ENTER',3,KOD,FNAMA,'BIN',LOG)

CALL FILDAT('WRITE',3,KOD,5)

IF (ITAPE.LE.1) GO TO 30

KD2DT2=4

KOD(2)=KD2DT2

CALL FILES('ENTER',4,KOD,FNAMB,'BIN',LOG)

CALL FILDAT('WRITE',4,KOD,5)

SET ARRAYS TO ZERO

YM(1,1)=0.

CALL RMOVE(YM(1,1),1,YM(2,1),1,IP*IY-1)

CALL RMOVE(YM(1,1),1,YSM(1,1),1,IP*IY)

CALL RMOVE(YM(1,1),1,UM(1,1),1,IP*IU)

CALL RMOVE(YM(1,1),1,EM(1,1),1,IP*IE)

CALL RMOVE(YM(1,1),1,EVEC(1,1),1,IP)

ILOG=0

MNOD=0

ICOUN=0

YSUM=0.

MAC=MAC0

REGULATOR LOOP

```

C
90      DO 500 ILOOP=1,NSAMP
        ICOUN=ICOUN+1
C
C      SIMULATE THE SYSTEM
C
        CALL SYSM
C
C      NO CONTROL IF PDIAG IS NEGATIVE
C
        IF (PDIAG) 162,98,98
C
98      DO 100 I=1,NP
100     YSM(I,1)=YM(I,1)/B0(I)
C
        CALL STURM1(YSM,UM,TM,PM,RL,NP,NA,NB,KREG,IPM)
C
C      MAKE SOME COVARIANCE MATRIX ENTRIES ZERO TO GET THE DESIRED
C      CONSTANT REGULATOR PARAMETERS
C
        IF (ICONS.EQ.0) GO TO 116
        DO 108 J=1,NP
          I1=JCONS(1,J)
          DO 108 I=1,I1
            IPOS=JCONS(I+1,J)
            DO 106 J1=1,IPM
106         PM(IPOS,J1,J)=0.
            DO 108 J1=1,IPM
108         PM(J1,IPOS,J)=0.
C
116         IF (ULIM) 162,162,120
120         DO 160 I=1,NP
          IF (UM(I,1)-ULIM) 140,140,130
130         UM(I,1)=ULIM
          GO TO 160
140         IF (UM(I,1)+ULIM) 150,160,160
150         UM(I,1)=-ULIM
160         CONTINUE
C
C      COMPUTE THE LOSS FUNCTION
C
162         DO 164 I=1,NP
164         YSUM=YSUM+YM(I,1)*YM(I,1)
C
170         CALL PRIM(2)
          IF (ITAPE.EQ.0) GO TO 500
          IF (MOD(ICOUN,IPOIN)) 500,174,500
174         DO 180 I=1,NABMAX
180         W(I)=TM(I,1)
          DO 182 I=1,NABMAX
            J=I+NABMAX
182         W(J)=TM(I,2)
            J=J+1
          W(J)=YSUM
          CALL FILDAT('WRITE',3,W,2*NABMAX+1)
          IF (ITAPE.GE.2) GO TO 184
          GO TO 500
C
C      FOR TEMPORARY USE. DIVIDE PARAMETERS BY TM(NA+1)-MATRIX
C
184         L=NA(1)*NP
          DET=TM(L+1,1)*TM(L+2,2)-TM(L+1,2)*TM(L+2,1)
C

```

```

BI11=TM(L+2,2)/DET
BI22=TM(L+1,1)/DET
BI12=-TM(L+2,1)/DET
BI21=-TM(L+1,2)/DET

```

C

```

W(1)=BI11*TM(1,1)+BI12*TM(1,2)
W(2)=BI11*TM(2,1)+BI12*TM(2,2)
W(3)=BI21*TM(1,1)+BI22*TM(1,2)
W(4)=BI21*TM(2,1)+BI22*TM(2,2)

```

C

```

CALL FILDAT('WRITE',4,W,K02DT2)

```

C

```

IF (ICOUN-IP1) 200,200,190
IF (MOD(ICOUN,IP2)) 500,200,500
WRITE(6,1000) (W(I),I=1,4)
FORMAT(' REG PAR: '4F6,2)

```

190

200

1000

C

C

```

END IF TEMPORARY CODE

```

C

500

```

CONTINUE

```

C

C

```

ASK FOR DESIRED CONTINUATION

```

C

```

CALL INDAM(2)

```

```

GO TO (550,600,550,550,550,550,999,999,550),ICONT

```

550

```

IF (ITAPE.EQ.0) GO TO 560

```

```

CALL FILES('CLOSE',3,KOD,FNAMA,'BIN',LOG)

```

C

```

IF (ITAPE.LE.1) GO TO 560

```

```

CALL FILES('CLOSE',4,KOD,FNAMB,'BIN',LOG)

```

560

```

GO TO (10,600,20,20,20,20,999,999,999),ICONT

```

C

600

```

CALL PRIM(3)

```

```

GO TO 90

```

C

999

```

STOP

```

```

END

```

SUBROUTINE INDAM(IN)

AUTHOR: ULF BORISSON 1973-11-20

IN-TYPE OF OPERATION

1: INITIALIZATION
2: CONTINUATION

COMMON YM(4,7),YSM(4,7),UM(4,10),EM(4,5),PM(16,16,4),TM(16,4),
2 NA(4),NB(4),BO(4),KSYS(4),KREG(4),ASYS(4,4,4),BSYS(4,4,4),
3 CSYS(4,4,4),N,NP,
4 EVEC(4),COV(4,4),ILOG,MNOD,MAC0,MAC,NABMAX,PDIAG,YSUM,
5 RL,ULIM,NSAMP,IP1,IP2,ICONT,ICOUN,
6 IP,IY,IU,IE,IPM,ITM,IABC,ICONS,JCONS(9,4),
7 FNAMA,FNAMB,W(20),BUFF(32),KOD(10),ITAPE,IPOIN

LV=10

GO TO (10,300),IN

WRITE(LV,1010)

IC=1

N=RTTFF(IC)

NP=RTTFF(IC)

WRITE(LV,1020)

IC=1

DO 20 I=1,NP

KSYS(I)=RTTFF(IC)

WRITE(LV,1030)

IC=1

DO 30 I=1,NP

KREG(I)=RTTFF(IC)

WRITE(LV,1040)

DO 40 K=1,N

IC=1

DO 40 J=1,NP

DO 40 I=1,NP

ASYS(J,I,K)=RTTFF(IC)

WRITE(LV,1050)

DO 50 K=1,N

IC=1

DO 50 J=1,NP

DO 50 I=1,NP

BSYS(J,I,K)=RTTFF(IC)

WRITE(LV,1060)

DO 60 K=1,N

IC=1

DO 60 J=1,NP

DO 60 I=1,NP

CSYS(J,I,K)=RTTFF(IC)

WRITE(LV,1061)

IC=1

ITAPE=RTTFF(IC)

IF (ITAPE.EQ.0) GO TO 61

WRITE(LV,1065)

```

CALL RLINE(9,8,BUFF,1)
I=1
130 CALL RABC(I,FNAMA,ABIND)
IF (ABIND.EQ.2 .OR. ABIND .EQ.4) GO TO 130
IF (ITAPE.LE.1) GO TO 134
CALL RLINE(9,8,BUFF,1)
I=1
132 CALL RABC(I,FNAMB,ABIND)
IF (ABIND.EQ.2 .OR. ABIND.EQ.4) GO TO 132
C
134 WRITE(LV,1066)
IC=1
IPOIN=RTTFF(IC)
WRITE(LV,1067)
IC=1
KOD(1)=RTTFF(IC)
C
61 WRITE(LV,1070)
IC=1
MTYP=RTTFF(IC)
COV(1,1)=0.
CALL RMOVE(COV(1,1),1,COV(2,1),1,IP*IP-1)
IF (MTYP-1) 66,62,66
62 DO 63 I=1,NP
63 COV(I,1)=1.
GO TO 68
C
66 IC=1
DO 67 J=1,NP
DO 67 I=1,NP
67 COV(J,I)=RTTFF(IC)
C
68 WRITE(LV,1075)
IC=1
MAC0=RTTFF(IC)
C
69 WRITE(LV,1080)
IC=1
DO 70 I=1,NP
70 NA(I)=RTTFF(IC)
WRITE(LV,1090)
IC=1
DO 80 I=1,NP
80 NB(I)=RTTFF(IC)
C
NABMAX=0
DO 86 I=1,NP
NAB=NA(I)+NB(I)
IF (NAB-NABMAX) 86,86,84
84 NABMAX=NAB
86 CONTINUE
NABMAX=NABMAX*NP
C
WRITE(LV,1100)
IC=1
DO 90 I=1,NP
90 B0(I)=RTTFF(IC)
C
140 WRITE(LV,1110)
IC=1
PDIAG=RTTFF(IC)
C
C
C INITIALIZE COVARIANCE MATRIX

```

```

PM(1,1,1)=PDIAG
PM(2,1,1)=0.
CALL RMOVE(PM(2,1,1),1,PM(3,1,1),1,IPM-1)
CALL RMOVE(PM(1,1,1),1,PM(2,2,1),1,IPM*IPM-IPM-1)
CALL RMOVE(PM(1,1,1),1,PM(1,1,2),1,IPM*IPM*(IP-1))

```

```

C
C
WRITE(LV,1112)
IC=1
ICONS=RTTFF(IC)
IF (ICONS.EQ.0) GO TO 120
WRITE(LV,1113)
DO 110 J=1,NP
IC=1
110 JCONS(1,J)=RTTFF(IC)
WRITE(LV,1114)
DO 114 J=1,NP
IF (JCONS(1,J).EQ.0) GO TO 114
I1=JCONS(1,J)
DO 112 I=1,I1
IC=1
JCONS(I+1,J)=RTTFF(IC)
IPOS=JCONS(I+1,J)
112 PM(IPOS,IPOS,J)=0.
114 CONTINUE
C

```

```

120 WRITE(LV,1120)
IC=1
ULIM=RTTFF(IC)
C

```

```

WRITE(LV,1125)
IC=1
INITI=RTTFF(IC)
IF (INITI) 96,96,92
92 DO 93 J=1,NP
WRITE(LV,1126)
IC=1
DO 93 I=1,NABMAX
93 TM(I,J)=RTTFF(IC)
GO TO 100
96 TM(1,1)=0.
CALL RMOVE(TM(1,1),1,TM(2,1),1,ITM*IP-1)
C

```

```

100 WRITE(LV,1130)
IC=1
NSAMP=RTTFF(IC)
RL=RTTFF(IC)
C

```

```

WRITE(LV,1140)
IC=1
IP1=RTTFF(IC)
IP2=RTTFF(IC)
GO TO 999
C

```

```

300 WRITE(LV,1300)
IC=1
ICONT=RTTFF(IC)
GO TO (999,100,61,69,140,58,999,999,999),ICONT
C

```

```

999 RETURN
C

```

```

1010 FORMAT(1H1,'ORDER OF SYSTEM',/
1' NUMBER OF OUTPUTS (MUST BE THE SAME AS NUMBER OF INPUTS)')
1020 FORMAT(' NUMBER OF TIME DELAYS OF SYSTEM, KSYS(I)')

```

```

1030  FORMAT(' NUMBER OF TIME DELAYS OF REGULATOR, KREG(1)')
1040  FORMAT(' A-MATRIX POLYNOMIAL')
1050  FORMAT(' B-MATRIX POLYNOMIAL')
1060  FORMAT(' C-MATRIX POLYNOMIAL')
1061  FORMAT(' ITAPE'/
      15X,'0: NO DATA SAVED ON TAPE'/
      15X,'1: DATA SAVED ON DT1'/
      15X,'2: DATA SAVED ON DT1 AND DT2')
1065  FORMAT(' FILE NAME')
1066  FORMAT(' IPOIN (EVERY IPOIN:TH POINT IS SAVED ON TAPE)')
1067  FORMAT(' NUMBER OF RECORDS IN THE FILE')
1070  FORMAT(' COVARIANCE MATRIX FOR THE NOISE'/
      15X,'1: UNIT MATRIX'/
      15X,'2: SPECIAL MATRIX (TO BE TYPED IN ROWS)')
1075  FORMAT(' ODD INTEGER FOR MNODI')
1080  FORMAT(' REGULATOR: '/
      15X,'NUMBER OF ALFA PARAMETERS')
1090  FORMAT(5X,'NUMBER OF BETA PARAMETERS')
1100  FORMAT(' B0(1)')
1110  FORMAT(' PDIAG'/' (PDIAG<0: NO CONTROL)')
1112  FORMAT(' ICONS (NUMBER OF CONSTANT REGULATOR PARAMETERS)')
1113  FORMAT(' NUMBER OF CONSTANT PARAMETERS IN ROW 1, 2, ...,NP')
1114  FORMAT(' TYPE ICONS POSITIONS OF CONSTANT REGULATOR '/
      1' PARAMETERS IN 1-VECTOR FOR THE ROWS 1, 2, ... ,NP')
1120  FORMAT(' LIMIT ON THE CONTROL SIGNAL'/
      15X,'<0 OR =0: NO LIMIT'/
      15X,'>0: LIMIT')
1125  FORMAT(' INITIAL VALUES OF THE REGULATOR PARAMETERS'/
      15X,'0: ZEROES'/
      15X,'1: SPECIAL')
1126  FORMAT(' ELEMENTS OF NEXT COLUMN')
1130  FORMAT(' NUMBER OF SAMPLE POINTS'/' RL')
1140  FORMAT(' IP1'/
      1' IP2')
1300  FORMAT(1H1,' CONTINUATION'/
      15X,'1: NEW INITIALIZATION'/
      15X,'2: CONTINUE THE SIMULATION'/
      15X,'3: CONTINUE FROM COVARIANCE MATRIX'/
      15X,'4: CONTINUE FROM REGULATOR'/
      15X,'5: CONTINUE FROM PDIAG'/
      15X,'6: CONTINUE FROM ITAPE'/
      15X,'/'
      15X,'9: STOP')
      END

```

SUBROUTINE PRIM(IPRI)

IPRI - TYPE OF OPERATION

1: PRINT INITIAL VALUES
2: PRINT SIMULATED DATA

AUTHOR: ULF BORISSON 1973-11-20

COMMON YM(4,7),YSM(4,7),UM(4,10),EM(4,5),PM(16,16,4),TM(16,4),
2 NA(4),NB(4),BO(4),KSYS(4),KREG(4),ASYS(4,4,4),BSYS(4,4,4),
3 CSYS(4,4,4),N,NP,
4 EVEC(4),COV(4,4),ILOG,MNOD,MACO,MAC,NABMAX,PDIAG,YSUM,
5 RL,ULIM,NSAMP,IP1,IP2,ICON,ICOUN,
6 IP,IY,IU,IE,IPM,ITM,IABC,ICONS,JCONS(9,4),
7 FNAMA,FNAMB,W(20),BUFF(32),KOD(10),ITAPE,IPOIN

IF (MNOD-1) 6,4,6
WRITE(6,1005)

GO TO (10,200,300),IPRI

PRINT INITIAL VALUES

WRITE(6,1010) N,NP
WRITE(6,1020) (KSYS(I),I=1,NP)
WRITE(6,1030) (KREG(I),I=1,NP)

WRITE(6,1040)
DO 20 K=1,N
WRITE(6,1050)
DO 20 J=1,NP
WRITE(6,1060) (ASYS(J,I,K),I=1,NP)

WRITE(6,1070)
DO 30 K=1,N
WRITE(6,1050)
DO 30 J=1,NP
WRITE(6,1060) (BSYS(J,I,K),I=1,NP)

WRITE(6,1080)
DO 40 K=1,N
WRITE(6,1050)
DO 40 J=1,NP
WRITE(6,1060) (CSYS(J,I,K),I=1,NP)

WRITE(6,1062) ITAPE
IF (ITAPE.EQ.0) GO TO 44
WRITE(6,1064) FNAMA,FNAMB
WRITE(6,1066) IPOIN,KOD(1)

WRITE(6,1090) MACO
WRITE(6,1095)
DO 45 J=1,NP
WRITE(6,1060) (COV(J,I),I=1,NP)
WRITE(6,1100) (NA(I),I=1,NP)
WRITE(6,1110) (NB(I),I=1,NP)
WRITE(6,1120) (BO(I),I=1,NP)
WRITE(6,1130) PDIAG
WRITE(6,1132) ICONS
IF (ICONS.EQ.0) GO TO 48
WRITE(6,1134) (JCONS(1,J),J=1,NP)
WRITE(6,1140) RL

```

WRITE(6,1150) ULIM
WRITE(6,1160) NSAMP
WRITE(6,1170)
DO 50 J=1,NABMAX
WRITE(6,1510) (TM(J,I),I=1,NP)

```

```

GO TO 999

```

```

PRINT SIMULATED DATA

```

```

IF (ICOUN-IP1) 250,250,210
IF (MOD(ICOUN,IP2)) 999,250,999
WRITE(6,1500) ICOUN,YSUM, (YM(I,1),UM(I,1),I=1,NP)
DO 260 I=1,NABMAX
WRITE(6,1510) (TM(I,J),J=1,NP)
GO TO 999

```

```

WRITE(6,1140) RL
GO TO 999

```

```

RETURN

```

```

FORMAT(' DECOMPOSITION OF COV IN SUBROUTINE MNODI HAS FAILED')

```

```

FORMAT(1H1,'ORDER OF SYSTEM: ',I1/
1' NUMBER OF OUTPUTS (INPUTS): ',I2)
FORMAT(' TIME DELAYS OF SYSTEM: ',8I7)
FORMAT(' TIME DELAYS OF REGULATOR: ',8I7)
FORMAT('// ' PARAMETERS OF THE SIMULATED SYSTEM' /
1' A-MATRIX POLYNOMIAL:')

```

```

FORMAT(1X)
FORMAT(8F10.3)
FORMAT(' ITAPE: ',I1)
FORMAT(' FILE NAMES: ',A5,5X,A5)
FORMAT(' IPOIN: ',I4,5X,'KOD(1)=',I5)
FORMAT('/ ' B-MATRIX POLYNOMIAL')
FORMAT('/ ' C-MATRIX POLYNOMIAL')
FORMAT('/ ' ODD INTEGER FOR MCNODI: ',I4)
FORMAT(' COVARIANCE MATRIX FOR NOISE')
FORMAT(' NUMBER OF ALFA PARAMETERS: ',8I7)
FORMAT(' NUMBER OF BETA PARAMETERS: ',8I7)
FORMAT(' B0(1): ',8F10.3)
FORMAT(' INITIAL VALUE OF DIAGONAL ELEMENT: ',F10.3)
FORMAT(' TOTAL NUMBER OF CONSTANT REGULATOR PARAMETERS:
1 ',I2)

```

```

FORMAT(' NUMBER OF CONSTANT PARAMETERS IN EACH ROW ',8I5)
FORMAT(' EXPONENTIAL WEIGHTING FACTOR:',F10.7)
FORMAT(' LIMIT ON CONTROL SIGNAL: ',F10.3)
FORMAT(' NUMBER OF SAMPLE POINTS: ',I6///)
FORMAT(' INITIAL VALUES OF REGULATOR PARAMETERS')

```

```

FORMAT(1X,I5,2X,F10.0,4X,5(F6.2,1X,F6.2,4X)/
11X,6(F6.2,1X,F6.2,4X))
FORMAT(8F11.3)
END

```

SUBROUTINE SYSM

SIMULATES A MULTIVARIABLE SYSTEM

$Y(I,T)+A(I,J,1)*Y(I,T-1)+\dots+A(I,J,N)*Y(I,T-N)=$
 $=B(I,J,1)*U(I,T-K-1)+\dots+B(I,J,N)*U(I,T-K-N)+$
 $+E(I,T)+C(I,J,1)*E(I,T-1)+\dots+C(I,J,N)*E(I,T-N)$

YM IS ORGANIZED AS YSM IN STURM1

UM IS ORGANIZED AS IN STURM1

EM-MATRIX OF PROCESS DISTURBANCES ORGANIZED AS FOLLOWS

EM(I,1)=E(I,T-1), EM(I,2)=E(I,T-2), ETC., I=1,...,NP
 RETURNED AS EM(I,1)=E(I,T), EM(I,2)=E(I,T-1), ETC,

AUTHOR: ULF BORISSON 1973-11-20

COMMON YM(4,7),YSM(4,7),UM(4,10),EM(4,5),PM(16,16,4),TM(16,4),
 2 NA(4),NB(4),BO(4),KSYS(4),KREG(4),ASYS(4,4,4),BSYS(4,4,4),
 3 CSYS(4,4,4),N,NP,
 4 EVEC(4),COV(4,4),ILOG,MNOD,MAC0,MAC,NABMAX,PDIAG,YSUM,
 5 RL,ULIM,NSAMP,IP1,IP2,ICONT,ICOUN,
 6 IP,IY,IU,IE,IPM,ITM,IABC,ICONS,JCONS(9,4),
 7 FNAMA,FNAMB,W(20),BUFF(32),KOD(10),ITAPE,IPOIN

CALL RMOVE(EM(IP,IE-1),-1,EM(IP,IE),-1,IP*(IE-1))
 CALL MNODI(EVEC,COV,IP,IP,MAC,ILOG,MNOD)
 CALL RMOVE(EVEC(1),1,EM(1,1),1,NP)
 CALL RMOVE(YM(IP,IY-1),-1,YM(IP,IY),-1,IP*(IY-1))

DO 100 I=1,NP
 YM(I,1)=EM(I,1)
 DO 100 J=1,N
 YM(I,1)=YM(I,1)-SCAPRO(ASYS(I,1,J),IABC,YM(1,J+1),1,NP)+
 1 SCAPRO(BSYS(I,1,J),IABC,UM(1,J+KSYS(I)),1,NP)
 1 +SCAPRO(CSYS(I,1,J),IABC,EM(1,J+1),1,NP)

RETURN
 END

SUBROUTINE STURM1(YSM,UM,TM,PM,RL,NP,NA,NB,K,IPDIM)

SELF TUNING REGULATOR FOR MULTIVARIABLE SYSTEMS

THIS VERSION HAS NO EXTRA TIME DELAY IN THE REGULATOR

AUTHOR: ULF BORISSON 1973-11-20

THE ALGORITHM IS BASED ON THE MODEL

$$Y(I) + A(I, J, 1) * Y(T-K-1) + \dots + A(I, J, NA(I)) * Y(T-K-1-NA(I)) =$$

$$= B(I) * (U(T-K-1) + B(I, J, 1) * U(T-K-2) + \dots + B(I, J, NB(I)) * U(T-K-1-NB(I)) + E(T)$$

YSM-MATRIX OF SCALED PROCESS OUTPUTS ORGANIZED AS FOLLOWS

YSM(I,1)=Y(I,T), YSM(I,2)=Y(I,T-1), ETC., I=1,...,NP

RETURNED AS YSM(I,1)=YSM(I,T), YSM(I,2)=Y(I,T),

YSM(I,3)=Y(I,2), YSM(I,4)=Y(I,3), ETC.

UM-MATRIX OF PROCESS INPUTS ORGANIZED AS FOLLOWS

UM(I,1)=U(I,T-1), UM(I,2)=U(I,T-2), ETC., I=1,...,NP

RETURNED AS UM(I,1)=U(I,T), UM(I,2)=U(I,T-2), ETC.

TM-MATRIX OF REGULATOR PARAMETERS ORGANIZED AS FOLLOWS

ALFA(1,1,1) ... ALFA(NP,1,1)

ALFA(1,NP,1) ... ALFA(NP,NP,1)

ALFA(1,1,NA(1)).. ALFA(NP,1,NA(NP))

ALFA(1,NP,NA(1)). ALFA(NP,NP,NA(NP))

BETA(1,1,1) ... BETA(NP,1,1)

BETA(1,NP,1) ... BETA(NP,NP,1)

BETA(1,1,NB(1)). BETA(NP,1,NB(NP))

BETA(1,NP,NB(1)). BETA(NP,NP,NB(NP))

DIMENSION YSM(1,1),UM(1,1),TM(1,1),PM(1,1,1),NA(1),NB(1),K(1)

COMMON/SLASK/ DUM(112),T(16),P(16,16),FI(64),DUM8(64)

ORGANIZE DATA FOR THE IDENTIFICATION ROUTINE

DO 50 I=1,NP

KI=K(I)

NAI=NA(I)

YIN=YSM(I,1)-UM(I,KI+1)

J=0

DO 10 J1=1,NAI

DO 10 J2=1,NP

J=J+1

L=KI+1+J1

FI(J)=-YSM(J2,L)

IF (NB(I)) 40,40,20

NBI=NB(I)

DO 30 J1=1,NBI

DO 30 J2=1,NP

J=J+1

L=KI+1+J1

FI(J)=UM(J2,L)

NPA=(NA(I)+NB(I))*NP

CALL RHQVE(TM(1,1),1,T(1),1,NPA)

CALL RHQVE(PM(1,1,1),1,P(1,1),1,256)

```

C      CALL RTLSID(T,P,FI,YIN,NPA,IPDIM,RL,RES,DENOM)
C          CALL RMOVE(T(1),1,TM(1,1),1,NPA)
50      CALL RMOVE(P(1,1),1,PM(1,1,1),1,256)

```

```

C      REORGANIZE DATA FOR NEXT STEP

```

```

C      FOR SIMPLICITY THE WHOLE ARRAYS ARE SHIFTED IN THIS VERSION

```

```

C      CALL RMOVE(YSM(4,6),-1,YSM(4,7),-1,24)
C      CALL RMOVE (UM(4,9),-1,UM(4,10),-1,36)

```

```

C      COMPUTE CONTROL SIGNAL

```

```

C      DO 100 I=1,NP
C      UM(I,1)=0.
C      J=0
C      NAI=NA(I)
C      DO 70 J1=1,NAI
C      DO 70 J2=1,NP
C      J=J+1
70      UM(I,1)=UM(I,1)+TM(J,1)*YSM(J2,J1+1)
C      IF (NB(I)) 100,100,80
80      NBI=NB(I)
C      DO 90 J1=1,NBI
C      DO 90 J2=1,NP
C      J=J+1
90      UM(I,1)=UM(I,1)-TM(J,1)*UM(J2,J1+1)
100      CONTINUE
C      RETURN
C      END

```