ERK'93

Portorož, Slovenija, 27. – 29. september 1993

Zbornik
druge Elektrotehniške in računalniške konference ERK'93
Proceedings of the Second
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Zvezek A / Volume A

Elektronika / Electronics
Telekomunikacije / Telecommunications
Avtomatika / Automatic Control
Močnostna elektrotehnika / Power Engineering
Merilna tehnika / Measurement – (ISEMEC 93)

Uredila / Edited by
Franc Solina, Baldomir Zajc

Slovenska sekcija IEEE / Slovenia Section IEEE

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Slovensko društvo za merilno-procesno tehniko (ISEMEC 93),
CIGRE,
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Društvo robotikov Slovenije,
Slovensko društvo za umetno inteligenco,
Slovensko društvo za razpoznavanje vzorcev.

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Sporočilo predsednika konference

Spoštovane gospe in spoštovani gospodje,

Elektrotehniška in računalniška konferenca postaja vsakoletno srečanje strokovnjakov na elektrotehničnem in računalniškem področju, pod okriljem Slovenske sekcije IEEE in združuje enkrat letno interese čim večih strokovnih društev. Strokovna društva skrbijo za program konference na svojih delovnih področjih, hkrati pa organizirajo svoje sestanke, okrogle mize in vabljena predavanja, kjer se je mogoče pogovoriti o strokovnih problemih, o tehnološkem in znanstvenem razvoju, mednarodnem povezovanju, izobraževalnih programih, o financiranju, zaposlovanju in podobno. Zato bo tudi letošnja konferenca ERK'93 mozaik sestavljen iz mnogih drobnih ozko usmerjenih strokovnih srečanj, ki bodo tako lahko kvalitetna, skupno dogajanje pa bo omogočalo mnoga interdisciplinarna srečanja in obisk vabljenih predavanj, zanimivih za širši krog poslušalcev.

Obliko konference smo letos že nekoliko spremenili. Prvi dan bo vrsta vabljenih predavanj. Jezik bo seveda angleški. Pričakujemo velik interes udeležencev in plodno razpravo s prominentnimi predavatelji iz tujine. Ostale sekcije bodo v slovenskem jeziku. Potrebujemo nek forum, kjer lahko naši raziskovalci razvijajo slovensko tehniško besedo, zato se slovenskemu jeziku na konferenci nismo odpovedali. Vmes pa bodo nekateri referati tudi v angleškem jeziku, teh pa bo gotovo iz leta v leto več, kakor se bo ERK uveljavljala.

Program konference smo razdelili na 10 strokovnih področij, ki imajo po več sekcij. Vsega skupaj je na konferenci 49 sekcij. Konferenčni zbornik je sestavljen iz 2 zvezkov:

Zvezek A:

Vabljena predavanja – skupaj 6 referatov,
Elektronika z 2 sekcijama in skupno 13 referati,
Telekomunikacije s 3 sekcijami in 21 referati,
Avtomatika s 6 sekcijami in 37 referati,
Močnostna elektrotehnika s 5 sekcijami in 33 referati,
Merilna tehnika s 5 sekcijami in 33 referati.

Zvezek B:

Računalništvo in informatika z 8 sekcijami in 44 referati,
Umetna inteligenca z 2 sekcijama in 11 referati,
Razpoznavanje vzorcev s 3 sekcijami in 18 referati,
Biomedicinska tehnika s 4 sekcijami in 26 referati,
Robotika z 1 sekcijo in 7 referati.

V obeh zvezkih je tako skupno 249 referatov. Upamo, da Vam bo zbornik v pomoč tako na konferenci kot pri Vašem nadaljnem strokovnem delu.

Baldomir Zajc
Predsednik konference

COMPUTER - AIDED LINEAR CONTROL SYSTEM ANALYSIS PROGRAM FOR PCs (CCP)

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C R O A T I A

ABSTRACT: The paper deals with software support to the analysis and synthesis of linear control system. The programs are oriented first to the transfer function of mathematical models and second to state variable mathematical models. Computer methods for transient response and frequency analysis are done. The analysis and synthesis of linear feedback systems is performed as well. The fundamentals of dynamic system simulation is also included.

KEYWORDS: Automatic Control; Computer Simulation.

1. INTRODUCTION

In the study of linear control theory one often encounters computation which, although theoretically simple can be impediment to the learning of the basic concepts. So for instance the labour involved in the determination of accurate frequency response of root locus plots or deterring the step response of the system may be prohibitive. In addition, it is often desirable to study high-order realistic design problems in order to emphasise the practical efficiency of the theory. Without a method of computational assistance, such problems are usually avoided because the computational effort required exceeds the benefits obtained.

Very powerful Computer Aided Control System Analyses and Design Programs for PCs are available today. For instance MATLAB having linear algebra and matrix computation is the foundation for providing the function specialised control engineering collected in "Control System Toolbox". The question is, why we made our own programs for Computer Control System Analysis and Design. First, all programs are printed with explanation in the publication "Computer-Aided Linear Control System Programs for PCs" [1] (CCP) and are available to all students of FESB- University of Split. Second, the whole program package needs the 0.7 Mb memory, and so can be used on all IBM PC versions. Finally, the choice of programs follows the lectures of Automatic Control [2], [3] on FESB-Split.

2. PURPOSE AND OUTLINE

Program CCP is divided into nine programs and twenty two subprograms. The first three are transfer function programs and the next six are state variable programs and other additional functions. The name of programs with short descriptions are:

(1) KORPO - This program is used to determine the roots of the polynomial from coefficients of the polynomial

(2) ODZIV - This program is used to determine the time response on unit step function

(3) POLAR - This programs allows to obtain the frequency of a rational transfer function. The polar Nyquist plot can also be obtained.

(4) BASMAT - The programs allows to compute the determinant, inversion,

characteristic polynomial and eigenvalues of a square matrix A. Also the BASMAT may be used to compute the resolvent matrix and state transition matrix.

(5) RTRESP - This program is used to determine the time response on input function having the Laplace transform of the rational function for linear feedback control system

(6) GTRESP - is used for graphical time response for linear feedback control system

(7) SENSIT - is used to study the variation of closed-loop poles of linear feedback system as some parameters vary.

(8) STVARFDBK - from known parameters in state space model, this program computes the transfer function, as can be used in designing the desired closed loop transfer function.

(9) DIGSIM - is a completely autonomous program and can be used to obtain the time response in general.

In general, the programs are limited to tenth-order problems. If necessary this limitation may be removed by extending the appropriate dimensions statements.

All subprograms used are described in Appendix A of publication [1]. In these subprograms, descriptions are included to assist the interested reader in understanding the operation of programs and also to permit the reader to generate new programs from these subprograms. Extensive use was made of subprograms in the development of these computer codes in order to facilitate such flexibility. For example one might wish to combine the sensitivity analyses and time response programs.

In order to use CCP the reader is not required to posses any knowledge of numerical methods. Only the very basic essential of the FORTRAN language and some knowledge of computer preparation are needed. For the reader who is familiar with FORTRAN, listings of the programs and subprograms are presented as well.

3. OUTLINE OF ONE SECTION

Each section is organised as follows

- Purpose of program
- Basic mathematical concepts
- Test problem (analytically)
- Program description
- Test program
- Listing of the program

Looking throught one section of the publication [1], for example-section (2) "ODZIV" an outline and impression will be given.

3.1. The purpose of program

The "ODZIV" program determines the time response on unit step function

$$W(s) = \frac{C(s)}{R(s)}$$

3.2. Basic mathematical concepts

The general expression of transfer function is

$$W(s) = \frac{C(s)}{(s + p_1)(s + p_2)\ldots(s + p_m)}$$

where $p_1, p_2, \ldots, p_m$ are poles of transfer function, and C(s) is a polynom. Laplace transform of time response will be:

$$C(s) = R(s) \cdot W(s) =$$

$$= \frac{1}{s} \cdot \frac{C(s)}{(s + p_1)(s + p_2)\ldots(s + p_m)}$$

The next step is 'partial fractional expansion":

$$C(s) = \frac{R_1}{s} + \frac{R_2}{s + p_1} + \ldots + \frac{R_{m+1}}{s + p_m}$$

where $R_1, R_2, \ldots, R_{m+1}$ are residiums.

After determining the residiums the next step is determination of the time response by use of the table of Laplace transforms.

$$c(t) = R_1 + R_2 \cdot e^{-p_1 t} + \ldots + R_{m+1} \cdot e^{-p_m t}$$

3.3. Test problem (analytically)

$$W(s) = \frac{K(s+2)}{(s+1)(s+3)}$$

Laplace transfer of time response, on applied step function is

$$C(s) = \frac{1}{s} \cdot \frac{K(s+2)}{(s+1)(s+3)}$$

After the partial function expansion we have

$$C(s) = K \cdot \left(\frac{2}{3}\frac{1}{s} - \frac{1}{2}\frac{1}{s+2} - \frac{1}{6}\frac{1}{s+3} \right)$$

By use of Table of Laplace transform the time response will be:

$$c(t) = K \cdot \left(\frac{2}{3} - \frac{1}{2}e^{-t} - \frac{1}{6}e^{-3t} \right)$$

3.4. Program description

First we call the program "ODZIV" by its code number <2>. On the screen we get the message:

Program za računanje odziva na jediničnu odskočnu pobudu

All the necessary instruction that are printed on the screen are to be followed. For example:

Enter the data in computer

- *define the number of factors in the numerator*
- *define the number of factors in the denominator*
- *define the degree of polynomial for all factors*

:

- *define coefficients of polynomials*
- *define computation time*
- *choose the way of output*

In this particular case we obtain the results as follows:

- the roots of polynomial in denominator
- the values of residues
- time response (numerically, graphically)

3.5. Program listing

```
      realzero(20),pole(20),y(202),x(202),z(202)
        temp1(20), temp2(20)
      complex root(20)
      write(*,5)
5     format(//)
      write(*,*)' PROGRAM ZA RACUNANJE
      write(*,*)'  ODZIVA NA JED. STEP  '
      write(*,5)
c
c     ucitavanje koeficjenata prijenosne funkcije
c
      call ing (zero,iz,pole,ip,temp1,temp2)
c
c     dodavanje pola na 0 u nazivnik,za
jedinicni step
c
      ip=ip+1
       do 90 i=2,ip
       pole(ip-i+2)=pole(ip-i+1)
90    continue
       pole(1)=0.
c
c     upis parametara za crtanje
c
100 write (*,*) ' Upisi ukupan broj tocaka za
racunanje (max. 200)'
       read (*,*) npoint
       write (*,*) ' Upisi vremenski korak
izmedu tocaka'
       read (*,*) tint
       write (*,*) ' Upisi izbor izlaza
numerickih vrijednosti : '
       write (*,*) '        ispis rezultata na
ekran= "1" '
       write (*,*) '        ispis i spremanje
rezultata za crtanje= "3" '
       read (*,*) nw
       if (nw .eq. 3) open(unit=3,file='odziv.dat')
c
            call proot1 (pole,ip,root,ir)
c
       write (*,5)
       write (*,*) ' KORIJENI NAZIVNIKA
UKLJUCUJUCI 1/s SU : '
c
       write (*,*)(root(i),i=1,ir)
       write (*,5)
c
c     provjera istih korijena nazivnika
c
       call eqroot (root,ir,iflag)
c
       if (iflag .ne. 1) go to 110
       write (*,*) ' Nazivnik ima iste
korijene,program stop '
```

```
      110 call respon
(pole,ip,zero,iz,root,ir,npoint,tint,y)
      write (*,120)
 120 format (//,12x,'vrijeme',16x,'odziv'/
',7x,16('-'),9x,12('-'))
c
      do 130 i=1,npoint
      z(i)=1.
      x(i)=tint*float(i-1)
      write (*,*) x(i),y(i)
      if(nw.eq.3)write (3,140) x(i),y(i),z(i)
 130 continue
c
 140 format (' ',5x,'t = ',F10.5,5x,'odziv(t) =
',F10.5,5x,f5.2)
c
      if (nw .eq. 3) close(unit=3)
      write(*,*)'     Zelite li ponoviti postupak
sa
      write(*,*)' novim podacima za
racunanje? DA=1 NE=2 '
read(*,*)i
if(i .eq. 1) go to 100
write(*,5)
write(*,*)' AKO STE ZAVRSILI S OVIM
PROGRAMOM I ZELITE'
write(*,*)' VIDJETI GRAF SA IZRACUNATIM
PODACIMA ZA ODZIV'
write(*,*)' NA JEDINICNU ODSKOCNU
FUNKCIJU, UPISITE BROJ'
write(*,*)'  " 10 ", <ENTER>, UPISITE "
LOTUS " <ENTER>
write(*,*)
write(*,*)' (podatci za graf su spremljeni u
FILE pod
write(*,*)'     imenom ODZIV.DAT kojega
pozivate iz
write(*,*)'                    LOTUS programa)
end
```

4. CONCLUSION

When applied, the program has proved very user-friendly, since a particular aim can be achieved by studying only the chapter dealing with the particular problem. If one knows the fundamentals of automatic control, it is not hard at all. The possibility of listing at the end of each chapter makes it possible for skilful users to make further extensions.

Too large extensions are not planned since, as explained in the introduction, a more complex (broader) program narrows the number of users and one of basic advantages of the software is decreased. For more complex problems we recommend MATLAB.

5. LITERATURE

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