Soft Analysis of Discreet System Function Introducing Recursive Method

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ABSTRACT

A major advantage of discrete domain analysis is the reduction of characteristic roots from infinite to finite numbers and consequent simplicity in the analysis and design of the controller. In this paper a new algorithm is   proposed towards the sample data control and also analysis the time complexity is find out. The algorithm has order of n2 time complexity.

Keywords

Sample Data Control, Time Complexity, Space Complexity, Discreet Domain System, Recursive Method

1. INTRODUCTION

A system in which the signal appears at one or more points in the system as a sequence of pulses or numbers usually equally spaced in time. A type of digital control system in which one or more of the input or output signals is a continuous, or analog, signal that has been sampled. There are two type of sampled signal: sampling in time and quantization in amplitude. Sampling refers to the process of converting an analog signal from a continuously valued range of amplitude values to one of a finite set of possible numerical values [1]. The sampled-data systems have received significant attention to describe nonlinear system characteristics [2].A major advantage of discrete domain analysis is the reduction of characteristic roots from infinite to finite numbers and consequent simplicity in the analysis and design of the controller[3]. Discrete time control theory comes up with unusual, but useful, control designs, with negative PID tuning parameters being one of them[4].

2. SAMPLED-DATA CONTROL REPRESENTATION WITH POLYNOMIAL

The sampled-data systems are used to describe nonlinear system characteristics. The discretization of a properly tuned continuous stable system expresses the preliminary approaches of nonlinear modeling. Considering the input test response as a step function, the generalized transfer function in Control System for sampled data control is represented as [5, 6, 7]

$$T(z) = \frac{C(z)}{R(z)} = \frac{A_0 z^0 + A_1 z^{-1} + A_2 z^{-2} + ...+A_n z^{-n}}{B_0 z^0 + B_1 z^{-1} + B_2 z^{-2} + ...+B_m z^{-m}} \quad (1)$$

Here, R(z) is the input function and C(z) is the output function. $A_0, A_1, A_2 .... A_n$ and $B_0, B_1, B_2..............B_m$ are the co-efficient. As the polynomial is in discrete domain, z = k is considered

$$C(k)B_0 + C(k-1)B_1 + C(k-2)B_2 + \cdots + C(k-m)B_m$$
$$= [\{R(k)A_0 + R(k-1)A_1 + R(k-2)A_2$$
$$+ \cdots + R(k-n)A_n\}]$$

Where k=0, 1, 2, 3,….

$$C(k) = \frac{1}{B_0}[\{R(k)A_0 + R(k-1)A_1 + R(k-2)A_2 + ... +$$
$$R(k-n)A_n\} - C(k-1)B_1 C(k-2)B_2 +$$
$$... + C(k-m)B_m\}]$$ Applying similar technique on the transfer function T(z)

$$T(z) = \frac{1.213z^{-1}+0.01471z^{-2}+0.07518z^{-3}-0.004608z^{-4}}{z^0+0.2121z^{-1}+0.08263z^{-2}+0.003374z^{-3}+0.0005531z^{-4}}$$
$$(2)$$

Coefficients of equation are:

A_0=0,A_1=1.213, A_2=0.01471, A_3=0.0751, A_4=0.004608

B_0=1, B_1=0.2121, B_2=0.0826, B_3=0.00337, B_4=0.0005531

Now for unit step input R(0)=R(1)=R(2)=…..=R(k)=1.So considering k=0,1,2,3,....,10,the values of C(0)C(1)C(2)C(3)C(4)..........C(10) are obtained as shown in the table 1.[8]

Table1. Table for values of c(k) for different values of k

C(k)	Generalized Expression
C(0)	$C(0) = \dfrac{1}{B_0}[A_0 R(0)]$
C(1)	$\dfrac{1}{B_0}[\{A_0 R(1) + A_1 R(0)\} - C(0)B(1)]$
C(2)	$\dfrac{1}{B_0}[\{A_0 R(2) + A_1 R(1) + A_2 R(0)\}$ $- \{C(1)B_1 + C(0)B_2\}]$
C(3)	$\dfrac{1}{B_0}[\{A_0 R(3) + A_1 R(2) + A_2 R(1) + A_3 R(0)\}$ $- \{C(2)B_1 + C(1)B_2 + \quad C(0)B_3\}]$
C(4)	$\dfrac{1}{B_0}[\{A_0 R(4) + A_1 R(3) + A_2 R(2) + A_3 R(1) + A_4 R(0)\}$ $- \{C(3)B_1 + C(2)B_2 + C(1)B_1 + C(0)B_4\}]$
C(5)	$\dfrac{1}{B_0}[\{A_0 R(5) + A_1 R(4) + A_2 R(3) + A_3 R(2) + A_4 R(1)$ $+ A_5 R(0)\}$ $- \{C(4)B_1 + C(3)B_2 + C(2)B_3 + C(1)B_4 + C(0)B_5\}]$
C(6)	$\dfrac{1}{B_0}[\{A_0 R(6) + A_1 R(5) + A_2 R(4) + A_3 R(3) + A_4 R(2)$ $+ A_5 R(1) + A_6 R(0)\}$ $- \{C(5)B_1 + C(4)B_2 + C(3)B_3 + C(2)B_4 + C(1)B_5$ $+ C(0)B_6\}]$
C(7)	$\dfrac{1}{B_0}[\{A_0 R(7) + A_1 R(6) + A_2 R(5) + A_3 R(4) + A_4 R(3)$ $+ A_5 R(2) + A_6 R(1)$ $+ A_7 R(0)\} - \{C(6)B_1 + C(5)B_2 + C(4)B_3 + C(3)B_4$ $+ C(2)B_5 + C(1)B_6 + C(0)B_7\}]$

3. ALGORITHM APPROACH TOWARD THE SAMPLE DATA CONTROL SIMULATOR GENERATOR

Algorithm: sample_datacontrol()

Step1: Start.

Step2: initialize the array A[] & B[]. /*coefficient of A & B are store in the array*/

Step3: initialize the variable sum & sum1 with 0.0.

Step4: Read k   /*for finding out put function c(k) of sample data control*/

Step5: for i=0 to k

 do R(i)=1

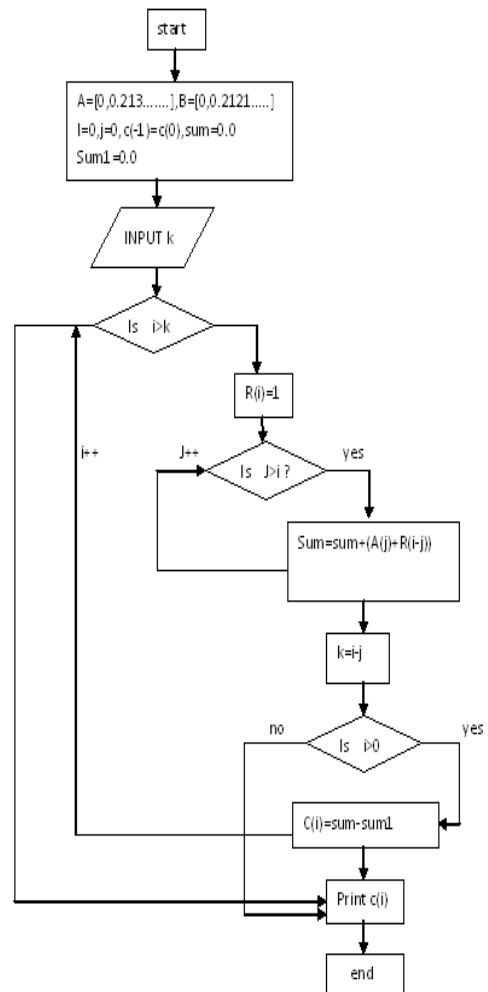Step6: for j=0 to i

Step7: sum=sum+(A(j)*R(i-j))

Step8: k=i-j

Step9: if(i>0) goto step 5

Step10: else

Step11: sum1=sum1+(C(k-1)*B(j))

Step12: C(i)=1/B[0]*(sum-sum1)

4. FLOW CHART FOR SAMPLE DATA CONTROL SIMULATOR GENERATOR

Fig 1: Flowchart for sample data control simulator generator

5. TIME SPACE COMPLEXITY REPRESENTATION

Time complexity of an algorithm T(n) is defined to be the time taken over all inputs of size n. The worst case time complexity is the maximum time taken. Space complexity of an algorithm T(n) is the amount of memory used over all inputs of size n. The worst case or average case running time or memory usage of an algorithm is often expressed as a function of the length of its input using big O notation. By writing T(n) = O(n2), the algorithm has order of n2 time complexity. [1]Big-O notation deals in upper bounds, technically speaking an algorithm is O(g(n)) for any and all(n) that grow asymptotically faster than f(n), so if an algorithm is O(n) it must be O(n2) [2].

Table2. Table for cost and time for finding the complexity

ALGO	COST	TIME
i)for i=0 to k	C_1	n
ii) R(i) = 1	C_2	n
iii) for j=0 to i	C_3	$\sum_{j=0}^{n} t_j$
iv) sum = sum + (A (j) * R(i-j))	C_4	$\sum_{j=0}^{n} t_j$-1
v) k = 1 − j	C_5	$\sum_{j=0}^{n} t_j$-1
vi) sum1 =sum1+(C(k-1)*B(j))	C6	$\sum_{j=0}^{n} t_j$-1
vii) C[i] = $\frac{1}{B[0]}$ *(sum-sum1)	C7	n

The running time of the algorithm is the sum of running times for each statement executed; a statement that takes Ci step to execute and execute n times will contribute Ci *n to the total running time. To compute T(n) , the running time of this algorithm on an input of n values, the sum of the product of the cost and time columns , obtaining

T(n) = C1*n + C2*n + C3 *$\sum_{j=0}^{n}$ tj + C4 *$\sum_{j=0}^{n}$ tj-1 + C5 *$\sum_{j=0}^{n} t$ j-1 + C6* $\sum_{j=0}^{n} t$ j-1 + C7*n

T (n) = C_{1*}n + C_{2*}n + C_3 *$\frac{n(n+1)}{2}$ + C_{4*} $\frac{n^2+n-2}{2}$ + C_5 * $\frac{n^2+n-2}{2}$ + C_{6*} $\frac{n^2+n-2}{2}$ + C_{7*}n

T(n) = C_1n + C_2n + C_7n + C_3 $\frac{n(n+1)}{2}$ + (C_4 + C_5 + C_6)($\frac{n(n+1)}{2}$ − 1)

T(n) = C_1n + C_2n + C_7n +$\frac{n(n+1)}{2}$(C_3 +C_4 + C_5 + C_6)- (C_4 + C_5 + C_6)

T(n) = (C_1n + C_2n + C_7n) +$\frac{n^2}{2}$ (C_3 +C_4 + C_5 + C_6) + $\frac{n}{2}$ (C_3 +C_4 + C_5 + C_6) - (C_4 + C_5 + C_6)

T(n) = (C_1 + C_2 + C_7)n + $\frac{n}{2}$ (C_3 +C_4 + C_5 + C_6) + $\frac{n^2}{2}$ (C_3 +C_4 + C_5 + C_6) - (C_4 + C_5 + C_6)

T(n) = n^2 ($\frac{C3}{2}$ + $\frac{C4}{2}$ + $\frac{C5}{2}$ + $\frac{C6}{2}$) + n (C_1+ C_2 + C_7 + $\frac{C3}{2}$ + $\frac{C4}{2}$ + $\frac{C5}{2}$ + $\frac{C6}{2}$) - (C_4 + C_5 + C_6)

6. CONCLUSION

The analysis of sampled-data systems leads to new challenging control problems in today's researcher. The paper is an attempted to solve the discreet domain analysis very easily. As per the future concern of this work, the simulation software will be developed to support the sampled data control field. So the running time can be expressed as : an^2 + bn + c Throwing the lower order term and ignoring the complexity can be written as O(n^2).

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