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Parametric and No Parametric Identification of a No Linear System With Search of Order

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Abstract: The developed method uses in a complementary manner, both parametric and no parametric identification techniques. Thus our algorithm consists in the development of a method based on tow approaches: The spectral analysis and Z-transform. The mixed method performance has been tested on simulated system of order 6 and in a no linear system.

Key words: Algorithm, simulation, spectral analysis, search of order, Z-transform, no linear system, parametric, no parametri

INTRODUCTION

To better model the physical systems, the Z-transform of the Dirac impulse[1,2], is generally used as an input; the impulse response of the system completely characterises its dynamic behaviour, knowing this last feature, its response to other arbitrary signals can be easily defined.

The Z-transform of the impulse response for most systems is defined by:

$$H(z) = \sum h(kT).z^{-k} \quad (1)$$

It can be written in the form:

$$H(z) = h(0) + h(T).z^{-1} + h(2T).z^{-2} + \ldots \quad (2)$$

It is considered for stable physical systems as infinite series; this infinite series can be exactly to the following fractional form, with a finite number of terms for both the numerator and the denominator:

$$H(z) = \frac{\sum_{m=0}^{M} B(m).z^{-m}}{1 + \sum_{n=1}^{N} A(n).z^{-n}} \quad (3)$$

According the Fourier transform principal, we know that the Z-transform of a sinusoid is given by:

$$H(Z) = \frac{C + A.Z^{-1}}{1 + B.Z^{-1} + Z^{-2}} \quad (4)$$

For a trigonometric series, we have:

$$H(Z) = \sum_{i=1}^{r/2} \frac{C_i + A_i.Z^{-1}}{1 + B_i.Z^{-1} + Z^{-2}} \quad (5)$$

with:

$$A_i = V_i.\sin(w_i.T - \theta_i) \quad (6)$$
$$B_i = -2.\cos(w_i.T) \quad (7)$$
$$C_i = V_i.\sin(\theta_i) \quad (8)$$

Where:
r: is the system order
wi: The frequency of the i^{th} sinusoid
Vi: The amplitude of the i^{th} sinusoid
T: The sampling period.

Parameters estimation:

Let us consider the previous illustrated system:

$$H(Z) = \frac{\hat{Y}(Z)}{I(Z)} = \frac{C_i + A_i.Z^{-1}}{1 + B_i.Z^{-1} + Z^{-2}} \quad (9)$$

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Table 1: Results Obtained from the implementation of our program for example

ith sinus	V_i	f_i	θ_i	A_i	B_i	C_i
1	120,4122	50	0,0132	0,3	-1,999	1,59
2	70,5971	100	1,0659	-60,68	-1,999	61,78
3	89,6595	150	0,5482	-43,07	-1,997	46,72

Table 2: Results Obtained from the implementation of our program for the electric power signal

ith sinus	Vi	fi	θi	Ai	Bi	Ci
1	42,8588	50	-0,9269	34,6735	-1,9998	-34,2736
2	32,5193	100	-0,,6637	20,8249	-1,9990	-20,0301
3	25,6564	150	-0,4422	12,0598	-1,9978	-10,9796
4	20,6642	200	-0,3013	7,3599	-1,9961	-6,1329
5	16,8535	250	-0,1734	4,2014	-1,9938	-2,9079
6	13,8360	300	0,0590	2,1114	-1,9911	-0,8152
7	11,8447	350	-0,0117	1,4377	-1,9879	-0,1389
8	10,2430	400	0,0493	0,7802	-1,9842	0,5060
9	8,9004	450	0,0712	0,6235	-1,9800	0,6337
10	7,8504	500	0,1097	0,3713	-1,9754	0,85599
11	7,2466	550	0,1655	0,0520	-1,9702	1,1947
12	6,4773	600	0,2124	-0,1555	-1,9646	1,3661
13	6,0123	650	0,2596	-0,3336	-1,9584	1,5440
14	5,2412	700	0,2949	-0,3933	-1,9518	1,5239
15	5,5555	1850	2,8607	-4,2173	-1,6716	1,5395
16	8,5941	1900	3,2116	-4,3207	-1,6542	-0,6022
17	14,8707	1950	3,5613	-2,8236	-1,6363	-6,0851
18	83,4700	2000	1,3341	-54,1463	-1,6180	81,1483
19	16,3821	2050	-0,6486	15,7523	-1,5994	-9,8958
20	11,4074	2100	-0,3813	9,8438	-1,5803	-4,2451
21	8,8532	2150	-0,1523	6,5194	-1,5609	-1,3429
22	6,8036	2200	-0,0317	4,5009	-1,5410	-0,2185
23	5,4930	2250	0,0593	3,3134	-1,5208	0,3258
24	12,0514	4000	1,8318	-6,5566	-0,6180	11,6429

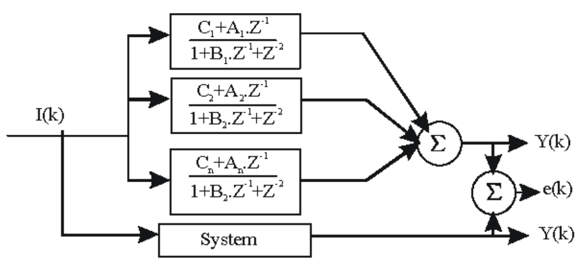

Fig. 1. Synoptic graph of the general model of the power electric signal

Where:

I(Z) : is the input excitation of the system,

$\hat{Y}$ (z) : system response .

The transformation to the discrete domain gives:

$$\hat{Y}(i) = -B_i\,\hat{Y}(i-1) - \hat{Y}(i-2) + C_i.I(i) + A_i(i-1) \quad (10)$$

Order search of the system: In order to find to exact order of the system to identify we have preceded as follows, [3,4]

Computation of our power signal FFT;

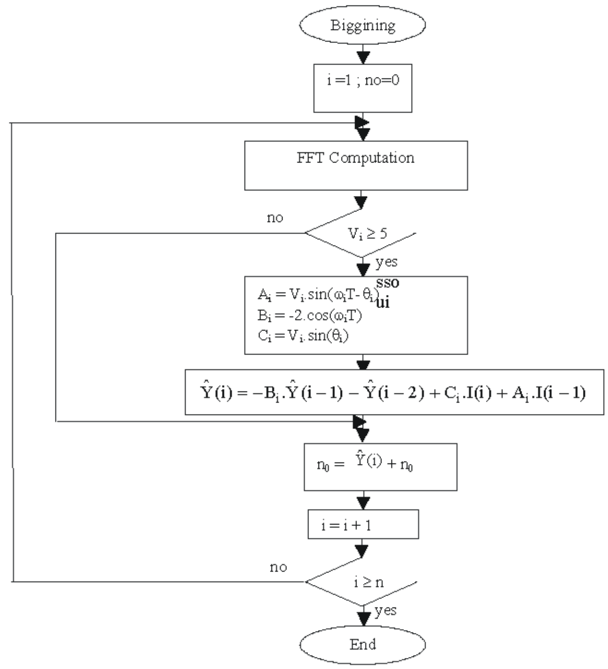

Fig. 2. General flow graph of the developed program

Acceptation of all FFT amplitudes those are greater or equal to 5.

Simulation: The simulation is done on a system of order 6 and its application to a real case that consists on a cutting system characterized by a signal representing the temporal evolution of its electric power witch is one of the most important parameter. The synoptic graph of the general model is represented in Fig. 1. The computation program proceeds according to the following steps (Fig. 2):

The first step: Computation of the real signal FFT and estimation of its parameters (amplitude, frequency and phase) with the basis of the previous hypothesis.

The second step: Computation of the parameters of the Ai, Bi and Ci model using equations (6), (7) and (8).

The third step: Reformulation of the estimated signal by using the parameters obtained in equation (10) and representation real signal and the estimated signal curves.

The fourth step: Computation and representation of the model FFT.

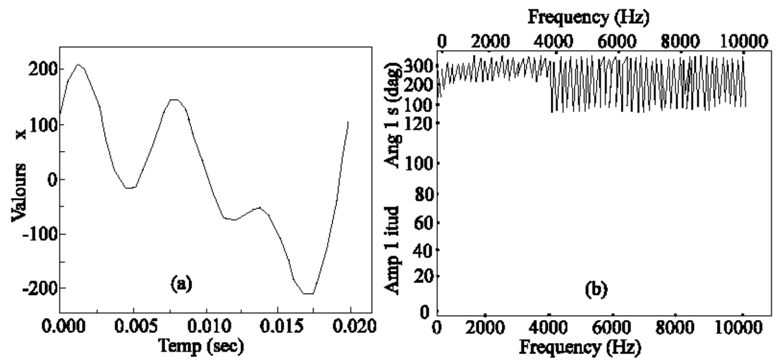

Fig. 3. a) Temporal evolution of the signal x(t) b)FFT of the signal x(t).

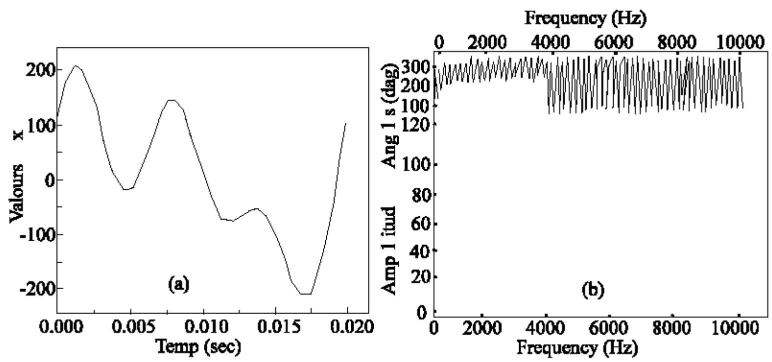

Fig. 4. a) Estimated model of signal x(t) b) Estimated FFT of signal x(t)

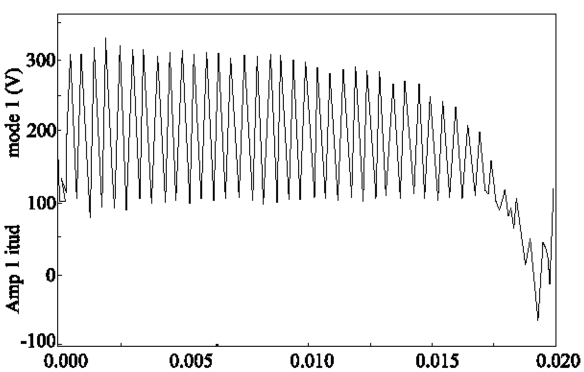

Fig. 5. Estimated signal of electric power

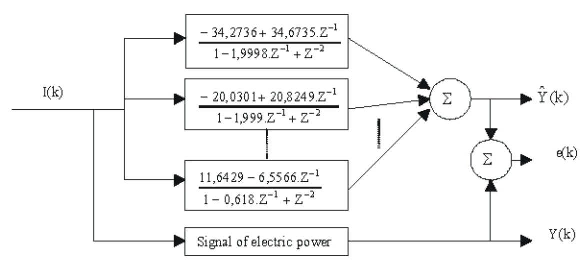

Fig. 6. Synoptic representation of the model

The 5th step: Comparison of the results.

Example : Let $x(t) = 120.\sin(2\pi.50t) + 70.\sin(2\pi.100t+\pi/3) + 90.\sin(2\pi.150t+\pi/6)$ a signal composed of three sinusoid varying with respect to time (20ms) whose sampling period is T= $5*10^{-5}$ s is represented in Fig. 3

The results obtained from the implementation of our program are summarised in Tables 1(example) and 2(signal of electric power).

After computing the FFT and the model parameters, we can define our model as follows:

$$\hat{Y}_1(k) = 1{,}999\hat{Y}_1(k-1) - \hat{Y}_1(k-2) + 1{,}59I(k) + 0{,}3I(k-1)$$
$$\hat{Y}_2(k) = 1{,}999\hat{Y}_2(k-1) - \hat{Y}_2(k-2) + 61{,}78I(k) - 60{,}68I(k-1)$$
$$\hat{Y}_3(k) = 1{,}997\hat{Y}_3(k-1) - \hat{Y}_3(k-2) + 46{,}72I(k) - 43{,}07I(k-1)$$
$$\hat{Y}(k) = \hat{Y}_1(k) + \hat{Y}_2(k) + \hat{Y}_3(k)$$

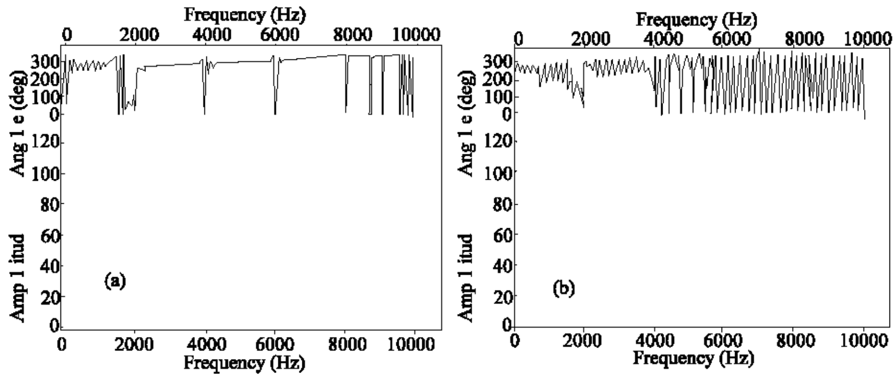

Fig. 7. a) Electric power signal
b) FFT of estimated signal

The Fig. 3 shows the curves of the system and its FFT while the figure 4 shows the curves of the model and its FFT.

The Fig. 5 shows the temporal evolution of the real power signal and the synoptic flow graph of the model is representing in figure 6.

The Fig. 7 shows the real signal FFT of electric power and its estimated one.

CONCLUSION

The simulation performed on system of order 6 shows that the identification has been realised in a satisfactory manner regarding to the negligible temporal and frequencial error.

The real spectrum of the electric power signal approaches very well the model[5]. The developed algorithm permits the identification of discrete systems with search of this order.

REFERENCES

1. Dahlquist and A. Bjoerck, 1971. NumericalMethods Prentice hall.
2. L. Ljung, 1987. System Identification Theorie for the user Hall Information and System Sciences Series,Englewood Cliffs,NJ,1987.
3. A.Bartil ,A.Abdelaziz,'Mixed Method of Discrete System Identification with optimal Search of its Order'1998. IEEE-SMC CESA'98 IMACS Multiconfernces.Computational Engineering in systems applications Nabeul- Hammmamet Tunisia.
4. M. Abdelaziz and A.Bartil, 1998. 'Frequency Discrete System Identification With optimal search of its order and bias removal', ICEL' 98 International Conference On Electrotechnics Univerity Of Sciences and Technology of Oran,USTOran, Algeria.
5. A. Bartil *et al.*, 2000 'Power signal modeling of acutting system', 16th IMACS WORLD CONGRESS Lausanne.