UDK 621.3.095.21:621.3.018

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SPECTRAL COMPONENTS DEFINITION OF THE SIGNAL WITH HARMONIC SIGNAL NONINTEGER PERIOD COMPONENTS

This article presents the results of simulation definition spectral analysis of signals, which consist of harmonic signals with non-integer periods. To analyze the discrete Fourier transform is applied. The change of spectral components studied by changing width of Fourier transformation by discarding samples. We found possibility of a more precise determination of the spectral components of the signal due to the accumulation of the results of DFT.

Keywords: window analysis, Fourier transform.

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ВИЗНАЧЕННЯ СПЕКТРАЛЬНИХ СКЛАДОВИХ СИГНАЛУ З НЕЦІЛИМИ ПЕРІОДАМИ СКЛАДОВИХ

В статті представлені результати моделювання визначення спектрального аналізу сигналів, що складаються з гармонійних сигналів із нецілими періодами. Для аналізу застосовано дискретне перетворення Фур'є. Досліджено зміну спектральних складових при зміні ширини вікна за рахунок відкидання відліків. Встановлено можливість більш акуратного визначення спектральних складових сигналу за рахунок накопичення результатів ДПФ.

Ключові слова: вікно аналізу, перетворення Фур'є.

I. Introduction

Transformation of Fourier is the basic instrument of analysis of signals in a frequency area – spectrology. From the mathematical point of view description of signals is in a sentinel area by a sentinel function $x(t)$ and in a frequency area by a spectral closeness $\dot{X}(\omega)$ it is identical, however predefined sense of the use of that or other form is certain benefits at the decision of that or other task [1].

$$\dot{X}(\omega) = \int_{-\infty}^{\infty} x(t) \cdot e^{-j\omega t} dt \; ; \tag{1}$$

It is known that periodic signals of kind $x(t) = x(t + mT_O)$ appear the row of Fourier as a sum of harmonic constituents, as in this case a basic accordion comes forward in an analysable signal only $\omega_O = 2\pi / T_O$ but it frequent components $k \cdot \omega_O$.

In practice spectrology of the real signals does not operate a continuous signal $x(t)$ and only by the eventual sequence of selections $x(n)$. At the same time application of expression (1) for the calculation of spectral function $\dot{X}(\Omega)$ it is impossible through the endless values of limit of adding up. For this reason in the technique of digital treatment of signals for a spectrology discrete transformation of Fourier is used.

II. Research Problems

At Fourier transformation, a sequence of counting out of analysable signal is periodically prolonged forward and back in time. Thus, if the values of the initial and eventual counting out of signal differ strongly, at a periodic reiteration on the joints of segments there are jumps which a spectrum broadens from, that additional constituents appear in a spectrum. It is the phenomenon which is named "spreading of spectrum" or "spectrum leakage". Spectrum leakage is possible to illustrate by the calculation of spectrum of discrete harmonic signal on an example (fig. 1). Discrete signals contain a 16 counting out of harmonic signal with periods even a 4 counting (the periodically prolonged signal is periodic) out and 6 counting out (the periodically prolonged signal contains gallops).

At research of spectral constituents not always there will be whole periods of signals in a signal. In article [2] it was founded that at implementation of measuring by sounding of explorer line on different frequencies the so-called rotation of reflections vectors takes a place from every damage. Thus, this rotation will depend only on distance to the object. In article [3] it was founded that existence of limited range of working frequencies for measuring accessible only part of working range. This limitation results in a volume, that the reflections vectors will have an initial corner of change of phase. As only in a point with frequency 0 Hertzs initial corners of reflections vectors will be 0 radian.

In most cases, a signal will contain the unwhole periods of signals. Moreover, there will be leakage spectrum of the probed signals in DFT. The high-quality selection of signals is complicated the origin of additional spectral constituents.

Transformation of signals is carried out in the systems. Systems, which change the form of signals (gain-frequency or phase-frequency description), suppression of noises, removal of obstacles, getting from the signals of certain information preferentially, dividing of signals by constituents, and others like that name filters. Filters with

any having a special purpose setting are the partial case of the systems of transformation of signals.

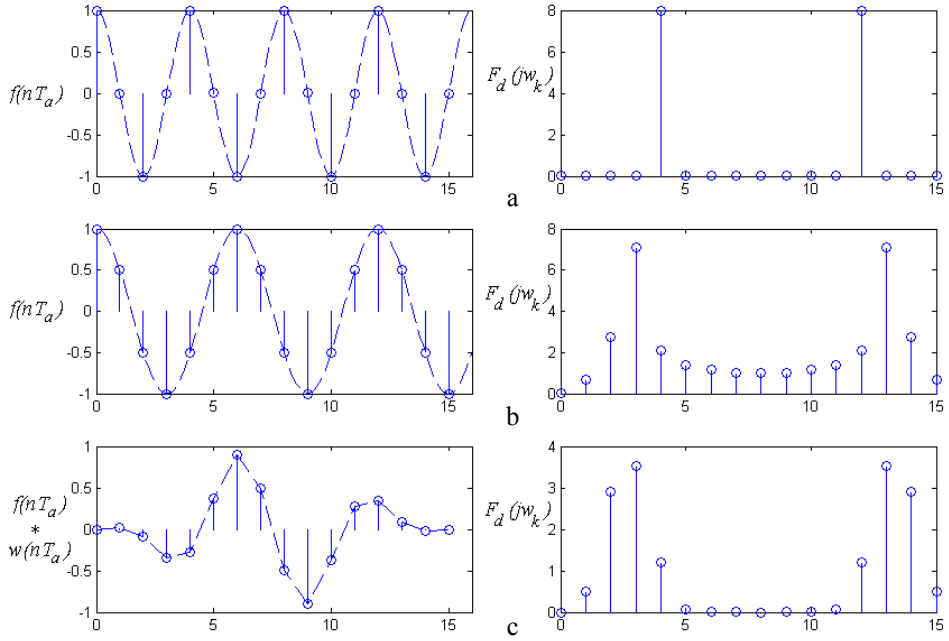

Fig. 1. DFT for the whole (a) and unwhole (b) number of periods of harmonic signal with application of window of Khann (c) of expansion of peaks in the spectrum of signal

III. Design of spectral constituents process selection at the change of DFT window width

For determination of methods of fight against spreading of spectrum of entrance signal, it is needed to set factors which result in the origin of this phenomenon. Understanding of reason of the phenomenon in this case, will allow accepting the row of measures on the removal of spreading. One of problems of digital filtration there is a presence of signals of different frequencies in an entrance signal, signals, which have both whole amount periods and not whole amount of periods in the window of spectrology, are thus present.

The phenomenon of spreading of spectrum consists in the origin of additional accordions in the spectrum of our signal. Thus these additional accordions complicate the process of authentication of accordions from the real constituents of signal. That has a process of «disguise» of signals. For that, to contest with spreading of spectrum the use of window functions is known in practice of digital analysis, but in this case they do not give a necessary us result, as they diminish the phenomenon related to unperiodicity of signal for an analysis. However, does not allow finding out signals with the unwhole period of reiteration, as concordantly DFT, total signal is a sum of periodic functions.

Therefore, if a signal is a sum of signals with different periodicity which is laid on certain duration of counting out. Thus, if to change the amount of counting out, fully clearly, that a signal with the unwhole amount of counting out can pass to the signal with the whole amount of periods, simultaneously with it, signals with the whole amount of periods will become signals with the unwhole amount of periods.

For the decision of task of determination of spectral constituents it is suggested to apply the polycyclic process of determination of spectral constituents of total signal with the permanent change of width of window of Fourier transformation. The algorithm of determination of spectral constituents of total signal by manipulation of width of window of DFT consists in the following:

1. Measuring of entrance signal is executed with determination of N of counting out.
2. The cycle of DFT is executed
3. Determine spectral constituents with most amplitude. The got result is memorized by adding to the result to the results of previous cycles of DFT.
4. Diminish the width of window by the casting-out of one counting out from the end.
5. If the amount of counting out anymore than minimum value of Nmin, pass to п. 2

With application of the offered algorithm software is created in the environment of MatLab.

On рисунках 2-5 the result of design for the signal of kind is rotined accordingly $S(t) = \sum U_i \cos(\omega_i + \varphi_i)$.

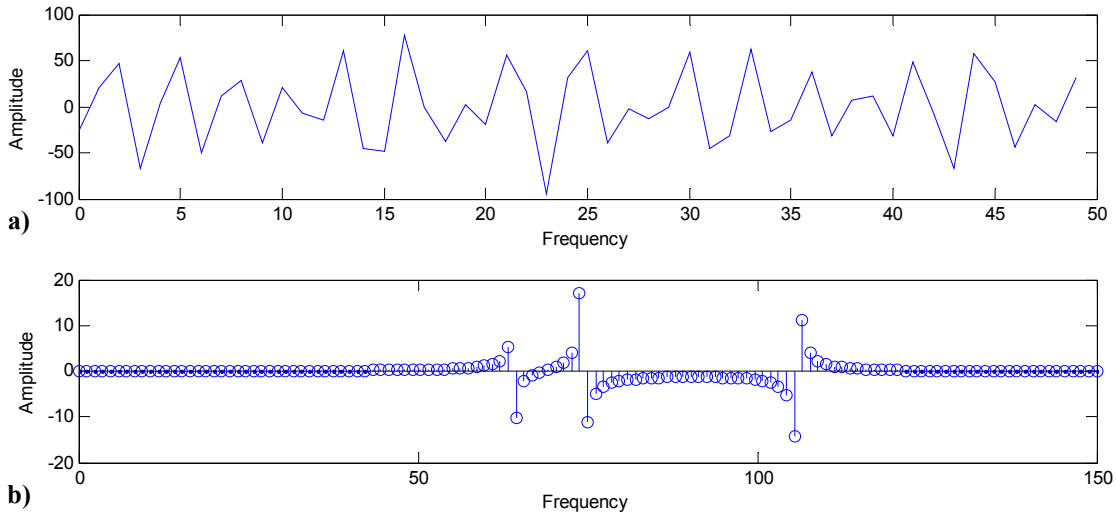

Fig. 2. A signal (a) and spectral transformation (б) is for the signal of kind

$$-20\cos(64t+0.7\pi)-32\cos(74.3t+1.2\pi)+49\cos(106.2t+3.2\pi)$$

As evidently from fig. 2 constituents are determined in a total signal, but their amplitudes do not answer set. So for the third signal amplitude less than for the second. Although in reality must be vice versa. Thus evidently, that the disfigured information is got on an entrance signal.

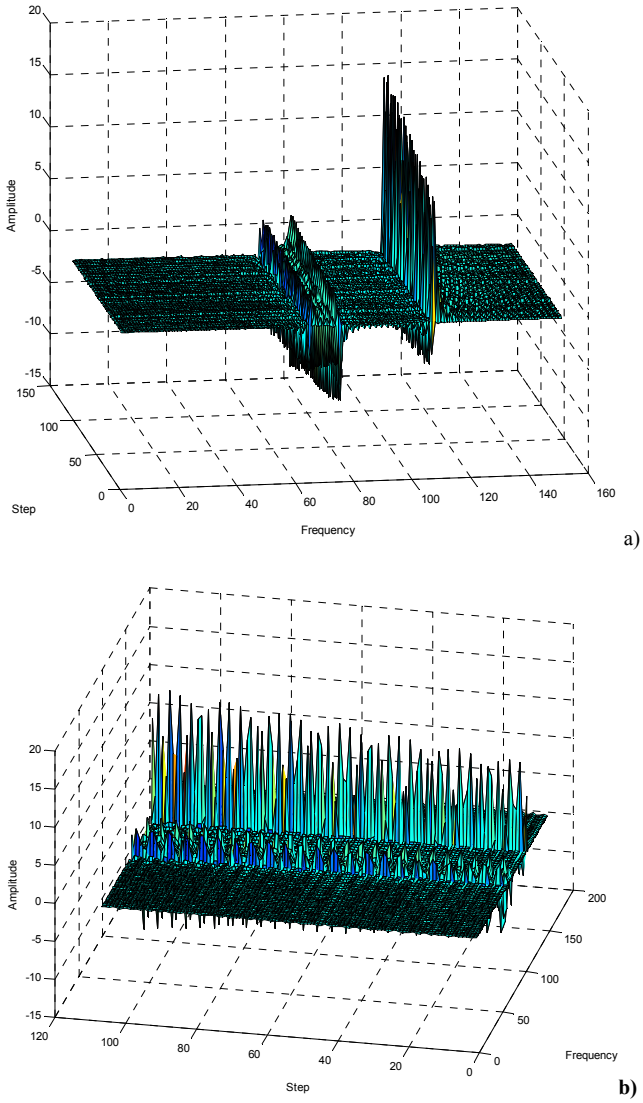

Fig. 3. A result of spectrology of signal is after setting of norms with application of the offered algorithm

On fig. 3 the result of spectrology of signal of setting of norms is rotined with application of the offered algorithm. On fig. 3, a) is rotined from the side of amplitudes and frequency, and fig. 3.b) from the side of amplitudes and counting out with the different width of window. As evidently on fig. 3,b) there is a selection of frequency constituents a signal at the change of width of window of DFT. But these constituents have different amplitudes for the different counting out.

On fig. 4. the result of total accumulation of spectral constituents is rotined. Unlike lines. 2, it is got a result more correctly answers correlation of amplitudes component of entrance signal.

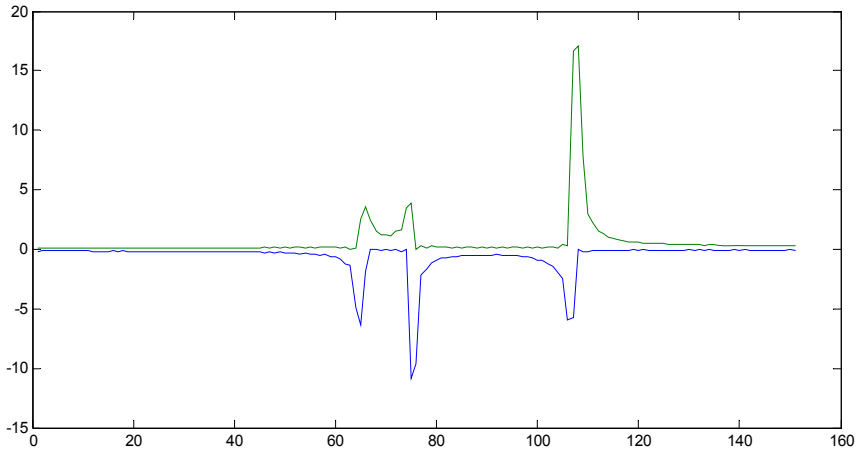

Fig. 4. A result of total accumulation of spectral constituents of got is at DFT with the different after a windows width

Conclusion

Consequently, the method of determination of spectral component signals, which consist of harmonious signals with an unwhole period in the window of DFT allows to set both the presence of spectral constituents and pick up a thread correlation of amplitudes of these constituents, is offered. However, synonymous renewal of not only amplitude but also sign of peak constituents and initial phase of signals requires subsequent researches.

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Рецензія/Peer review : 24.1.2014 р. Надрукована/Printed :14.2.2014 р.
Рецензент: д.т.н., проф. Троцишин І.В.