

VIRTUAL INSTRUMENT FOR HARMONIC ANALYSIS

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Abstract. Harmonic analysis of periodic signal is a major importance for determining the energy quality. This paper, presents a virtual apparatus for frequency analysis of periodic signals. The virtual apparatus use a NI 6221 DAQ module to acquire the periodic signal. The soft for the virtual apparatus is realized in LabView programming medium. The panel and diagram windows of apparatus are presented.

Keywords: data acquisition, LabView, frequency analysis, virtual apparatus.

1. INTRODUCTION

Measurement apparatus producers are searching for ways to diversify the possibilities of using measurement apparatus: this is why these have been fitted with a series of functions, connection possibilities for numeric measurement systems, etc. But with all of these fittings, a measurement apparatus will never be able to satisfy all of the needs for various applications.

At this time, virtual instrumentation is gaining an accelerated spread due to the fact that it allows the user to adapt the virtual measurement apparatus to the particular needs of the client's application. Specific applications can be realized using a data acquisition board, a computer and an adequate acquisition soft which would satisfy all the needs of a data application: further more, the instrument obtained this way can easily be modified and adapted to eventual changes in the measuring process.

2. THE DESCRIPTION OF A REALIZED VIRTUAL INSTRUMENT

Harmonic analysis of periodic signals allows us to point out their frequency spectrum and to determine the influence of different harmonics in the general structure of the signal. These have a special importance in the case of deformed alternative voltage tensions (the deformation being determined by the inductive charges and by the harmonics introduced by inverters with semiconductors). The presence of superior order harmonics can sometimes lead to measurement errors in the case of analogical apparatus and to inadequate behavior in the case of consumers.

A virtual instrument capable of frequency analysis of non sinusoidal periodic signals with frequencies up to 1 KHz was realized

The acquisition of analyzed to be signals was realized with a PCI 6211 acquisition board made by National Instruments, which allows 16 analogical channels acquisition with a maximum frequency of 250KHz for charges between $\pm 0.2V$ and $\pm 10V$. The acquisition program is an application realized in LabView environment. The panel window of the realized instrument's base component, on which command and display elements used by the program are placed, is shown in figure 1.

On the frontal programs panel the next input/output elements are presented.

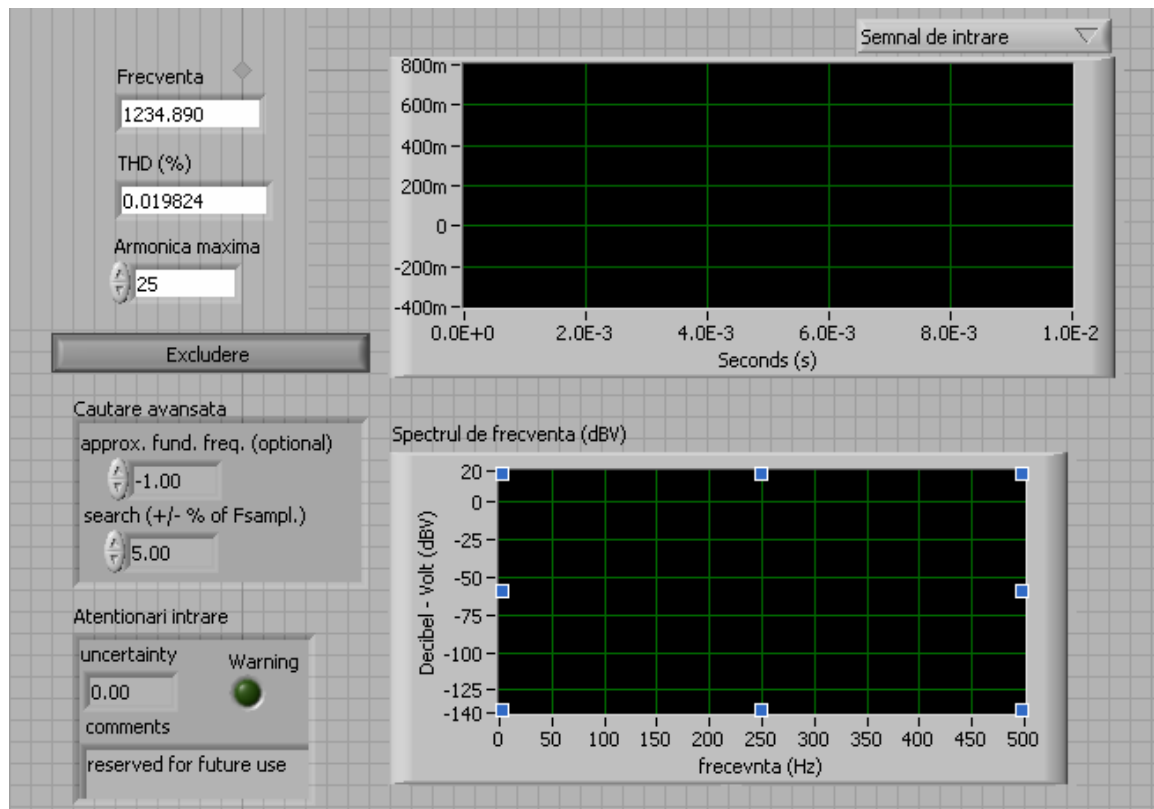


Figure 1

Input elements:

- a numeric indicator, "Harmonica maximum", through which analysis will be realized. Its maximum value is of 25.
- A graphic type display element with an input signal label through which the evolution in time of the acquired signal is displayed (the signal submitted to analysis).
- An advanced search label element in which the estimated fundamental frequency value is set as well as the maximum errors around this.

These input data are optional in the case, in which the frequency value is negative and the determination of the fundamental is realized automatically.

- A last logic element allows the inclusion/exclusion through an antialiasing filter.

Output elements:

- A graphic element with a frequency analysis spectrum label on which the harmonic values, presented in the analyzer's signal structure, are displayed.
- A numeric element with a frequency label on which the fundamental values of the measured signal are displayed.
- A numeric element with a THD label on which the percentages for total harmonics distortion is displayed.
- A display element with an input warnings label on which messages regarding the incompatibility between the signal submitted to analysis and the analysis program are displayed.

The diagram bloc window of the acquisition program is presented in figure 2.

The signal is taken from the process with the help of a DAQ DATA acquisition function and it is applied to a subroutine which realizes harmonic analysis

Its pictogram is presented in figure 3.

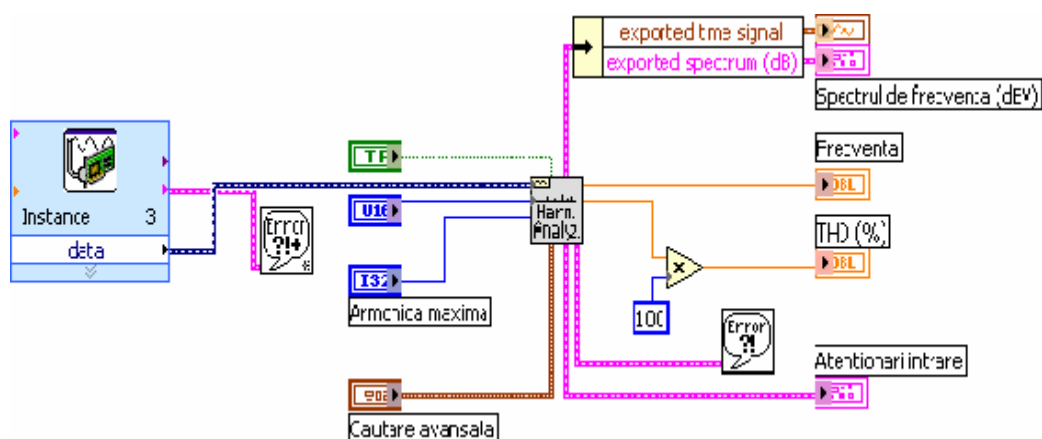


Figure 2

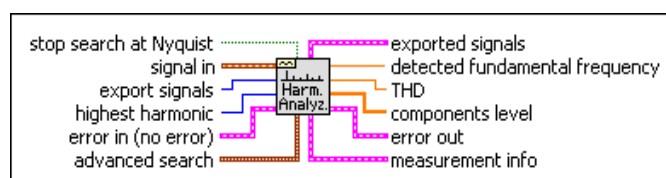


Figure 3

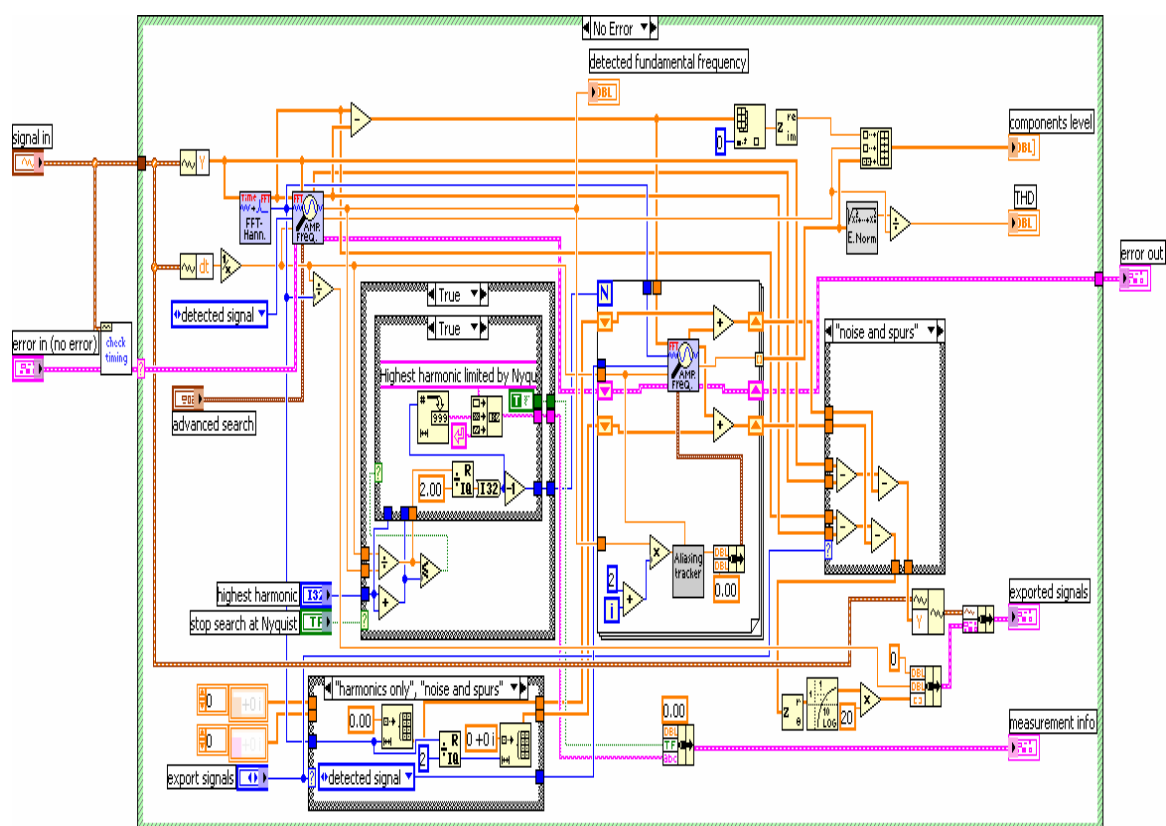


Figure 4

The general structure of this program is presented in figure 6.

If there are no acquisition errors the program is realized cyclically.

For a proper Fourier analysis a specific program activated by the icon in figure 4 is used.

This is based on a specific LabVIEW function which implements a numeric algorithm of fast Fourier transformation whose icon is presented in figure 5.



Figure 5



Figure 6



Figure 7

As we carry on, the frequency spectrum's components are analyzed. These are arranged into a coherent data string and sent to the display devices.

The "case" structure is used to take data.

The usage of an antialiasing filter is determined by the position of the inclusion/exclusion logic input elements.

2.1. The program's components:

The harmonic distortion analyzer

It takes a signal and realizes a complete harmonic analysis including the measurement of fundamental signal's frequency and of harmonics, returning the fundamental frequency of all harmonic amplitude levels and all of the harmonic distortions (THD- total harmonic distortion)

This polymorphic VI (virtual instrument) can be used to analyze a shape or an arrangement of wave/signal shapes.

The data type connected to the signal's input determines a polymorphic case which is then used.



stop search at Nyquist – it should be set for TRUE(the initial value) so that it would include only frequencies smaller than the Nyquist frequency, or half of the selection rate in the harmonic search. When it is set to FALSE, this virtual instrument continues searching for the frequency domain further than Nyquist saying that these high frequency components have results which are of no interest for the following equations:

0 none—fastest computation

1 input signal

2 fundamental signal—single sine tone

3 residual signal—signal minus tone

4 harmonics only—detected harmonics

5 noise and spurs—signal minus tone and harmonics



signal in – it is the input for the domain type signal



export signals – it selects the signals which have to be exported to exported signals



error in – describes the error conditions that appear before this virtual instrument or function runs. The initial value is NO ERROR. If an error appears before this virtual instrument or function runs, the virtual instrument or function transfers the error value to error out. This virtual instrument or function runs normally only if no error has occurred before the virtual instrument or function runs. If an error occurs while the virtual instrument or function is running, it runs normally and it sets the error status to error out. *Simple Error Handler* and *General Error Handler* of virtual instruments are used to display the description of error the code.

Error in and error out are used to check the errors and their specific execution order connecting error out of a node to error in of the next node.

 **status** – it is TRUE(x) if an error has occurred before the virtual instrument or function had run, or FALSE (checkmark=check) to indicate an amortization signal or because no error has occurred before the virtual instrument or function had run. The initial state is FASLE.

 **code** – it is the error or warning code. The initial state is 0. If the status is TRUE, the code is an error code without 0. If the status is FALSE, the code is 0 or a warning code.

 **source** – describes the errors or the warning signal origins and it is in most cases the name of the virtual instrument or function which produces the error or warning signal. The initial state is an empty string.

 **advanced search** – controls the search area domain frequency which is the frequency's center and width, used to find the fundamental frequency signal.

 **approx freq.** – it is the centered frequency used in the frequency search domain for the fundamental frequency signal.

 **search** – it is the width of the frequency, as a model rate percentage, for searching the frequency domain of the fundamental frequency signal.

 **exported signals** – contains specific export signals.

 **export time signal** – it is a wave shape continuing the time signal selected by the export signals.

 **f0** – it is the spectrum's start frequency expressed in Hz.

 **df** – it is the spectrum's resolution frequency expressed in Hz.

 **dB Spectrum (Hann)** – it is the spectrum's resolution frequency expressed in Hz.

 **detected fundamental frequency** - contains the detected fundamental frequency which results from the frequency domain search. **Advanced search** is used to se the frequency's search area. All of the harmonics are measured in whole multiple numbers of this fundamental frequency.

 **THD** – contains the total measured harmonic distortion up to and including **highest harmonic**. THD is defined as the harmonics proportion of RMS to the fundamental signal's amplitude. To calculate THD the percentage must be multiplied by 100.

 **components level** – contains the volt measured harmonics amplitudes arrangement, if the signal is in volts. The arrangement's index is the harmonic number including 0 (DC), 1 (fundamental), 2(second harmonic),..., n (nth harmonic), up to and including **highest harmonic**.

 **error out** – contains error information. If error in indicates the appearance of an error before this virtual instrument or function has run, error out contains the same error information. This way, the error's status produced by the virtual instrument or function is described. Right click is done on the error out indicator from the frontal panel and **Explain Error** is selected from the shortcut menu for further information about the error.

3. CONCLUSIONS

A virtual instrument which allows harmonic analysis of periodic signals of a limited strip up to 1 kHz was realized.

A PCI 6221 acquisition board was used to acquire signals. The signal has been taken from the process with the help of a DAQ DATA acquisition function.

The virtual instrument was realized in LabVIEW programming environment.

REFERENCES

Users guide:

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