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METHOD FOR DETECTING NARROW SPIKES

C. Donciu, C. Fosalau, M. Cretu

Technical University Gh. Asachi, Faculty of Electrical Engineering, Iasi, Romania

Abstract – In the present paper is presented a method for on-line narrow spike detention. The method consists of successive derivations of the signal till the only event remains significant in the sequence

Keyword: narrow spike

1. INRODUCTION

It is well known that nowadays, electric power quality plays a decisive role in life, reliability and well-operating behaviour of almost all electric apparatus and devices. As known, the ideal voltage shape delivered by power distribution systems is sinusoidal. In practice, non-periodic disturbances caused mainly by electric and electronic switches under inductive or capacitive loads appear, leading to serious alter of power quality. These disturbances appear as transient events in the form of narrow spikes or gaps in the continuous sinusoidal voltage shape. Most of them have values as much as 2 to 2.5 times greater than the normal value. Obviously, if a spike occurs close to the peak value of the sinusoid, it means that unacceptable high-voltage peaks are generated, that may cause serious damages to insulators and electronic devices.

2. NARROW SPIKES DETECTIONS

Our paper describes a method and an instrument based on digital techniques, designed to detect and measure spikes or gaps in sinusoidal voltage shapes as narrow as 1ms with respect to normal power frequency of 50Hz.

One of the most utilised methods for detecting narrow spikes is using the Digital Fourier Transform {1,2]. The samples of a signal obtained from a DAQ device constitute the time domain representation of the signal. This representation gives the amplitudes of the signal at the instants of time during which it had been sampled. The representation of a signal in terms of its individual frequency components is known as the frequency domain representation of the signal. The frequency domain representation could give more insight about the signal and the system from which it was generated. The algorithm used to transform samples of the data from the time domain into the frequency domain is known as the discrete Fourier transform or DFT. The DFT establishes the relationship between the samples of a signal in the time domain and their representation in the frequency domain. A simple way to improve the spectral characteristics of a sampled signal is to apply smoothing windows. When performing Fourier or spectral analysis on finite-length data, you can use windows to minimize the transition edges of your truncated waveforms, thus reducing spectral leakage. When used in this manner, smoothing windows act like predefined, narrowband, lowpass filters. This method, however, supposes some restrictions like

i) necessity of acquiring a large number of periods;
ii) the number of periods must be integer
iii) windowing must be employed.

Our instrument presents some features that make it useful in real condition of operation. Some of them are: signal frequency can be variable in time, the amplitude can be also variable, the noise can be present in signal, on-line processing.

In Fig. 1 are presented the main parameters of the narrow spike [3]:

$$t_{spike}=t_1-t_0 \quad (1)$$

$$dU_{spike}=U_{spike}-U_{spike}(t_0) \quad (2)$$

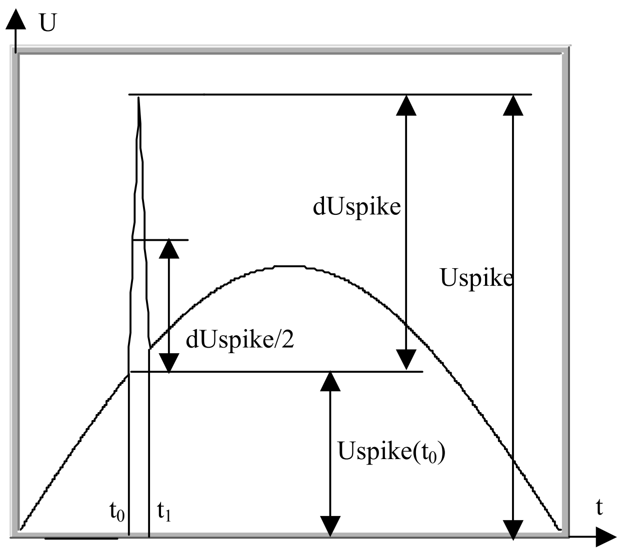

Fig. 1. Spike parameters

Because the event period is about 5 % of the signal period, the signal must be sampled with a frequency 100 times greater than the signal frequency.

The signal is continuously acquired by using a circular buffer. The sequence picked up and stored into the buffer at once covers an interval of nine signal periods, but data processing is performed on ten periods, in order to not fail to catch a spike occurring eventually at the boundary between two adjacent sequences. Nine periods come from the actual acquisitions, while the tenth represents the last period taken from the previous sequence. This one is stored in the cash memory by utilising a shift register.

In Fig. 2, a real case where a short transient represented by a narrow spike is presented. The ten periods shown in the figure represent just the sequence processed according to the algorithm.

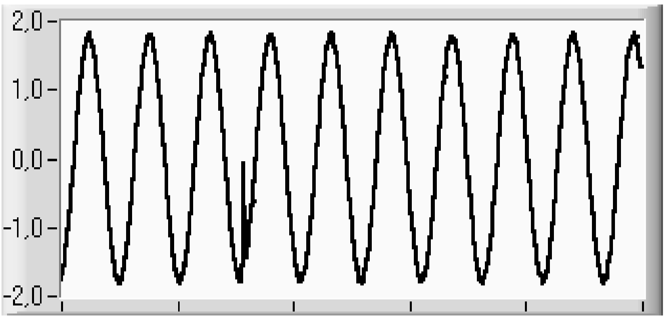

Fig. 2. Sequence processed

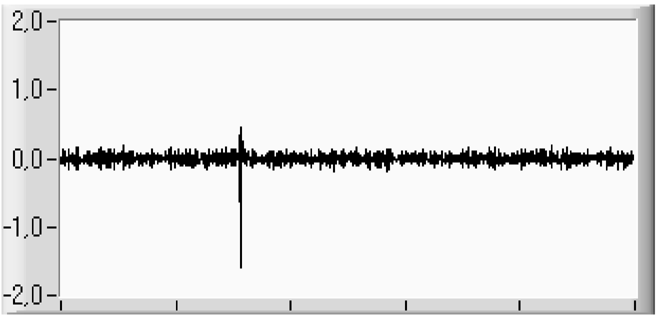

Fig. 3. Event detection

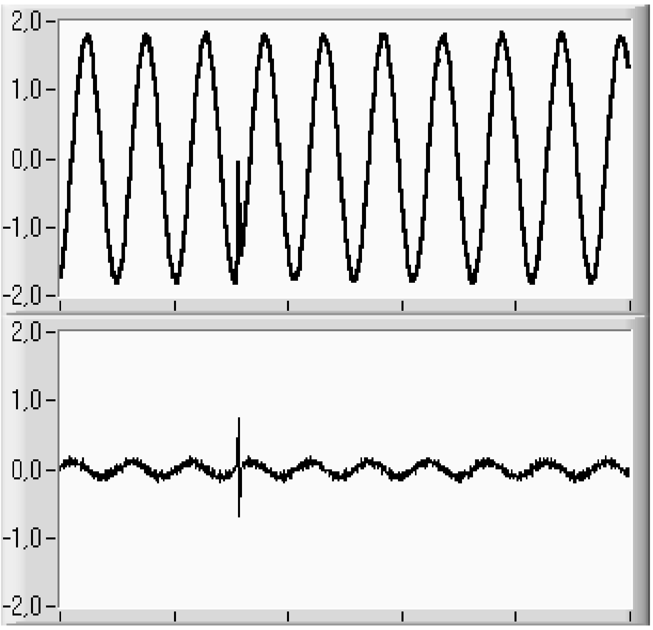

Fig. 4. Sequence after one derivation

In principle, for detecting the above event, three successive derivations are performed to the sequence, which in the digital technique means that we have to make iterative differences between adjacent samples.

Following to this technique, after the third derivative, the samples corresponding to the normal sinusoid become insignificant in amplitude with respect to those corresponding to the transient.

From Fig. 3 one observes that the event detection becomes very easy to accomplish when a level threshold is imposed.

For subsequent analysis, only the sequences containing events are stored on the disk, thus considerably saving the disk space.

In order to illustrate the signal evolution for the duration of successive derivation, in Fig. 4, 5 and 6 is revealed the cases for one, two and four derivations.

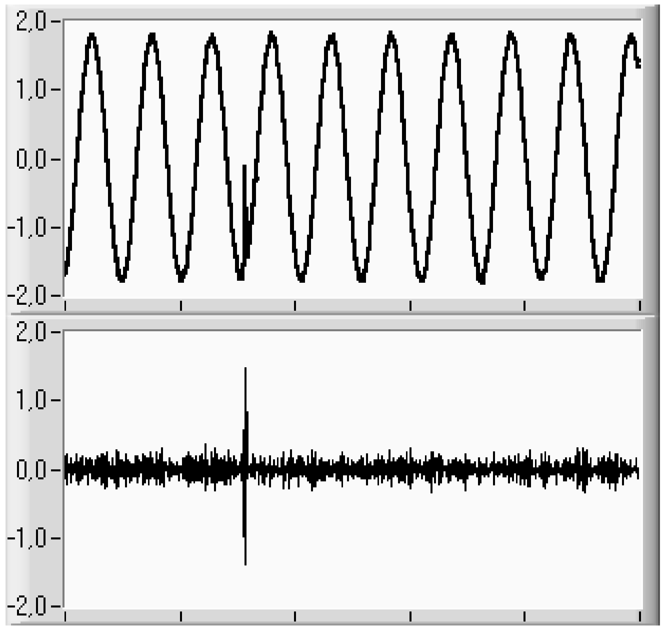

Fig. 5. Sequence after two derivations

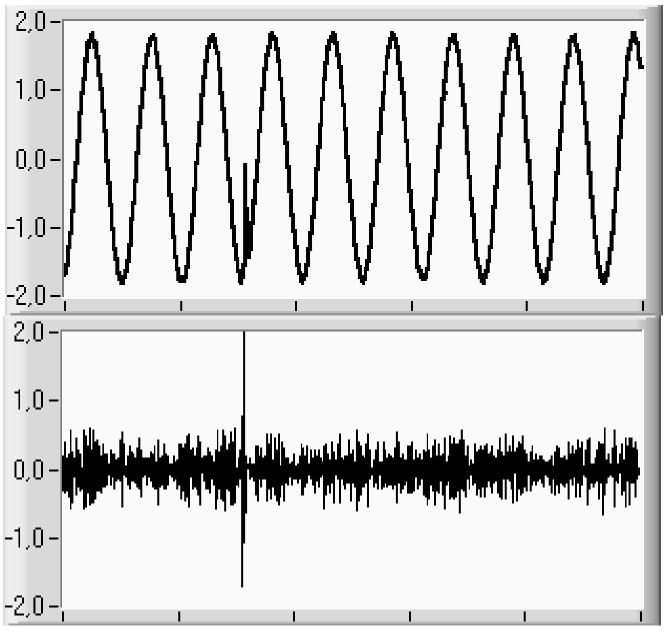

Fig. 6. Sequence after four derivations

Sampling frequency utilised in laboratory when testing the instrument was 5 kHz. The voltage under test had time variable amplitude whilst frequency oscillated in the 48 to 52 Hz interval. The signal was accompanied by a white noise of 4 % magnitude regarding the signal amplitude. The spike width was maximum 5 % of signal period. The virtual instrument responsible for signal acquisition and processing was developed in the graphical language LabVIEW [4,5].

graphical display tools, which are included on the VI front panel (Fig. 7), in order to allow the on-line monitoring of the dynamic performance of the system. As the acquisition diagrams are normally familiar for the VI users, only the diagrams referring to the successive derivations is presented in the paper (Fig. 8).

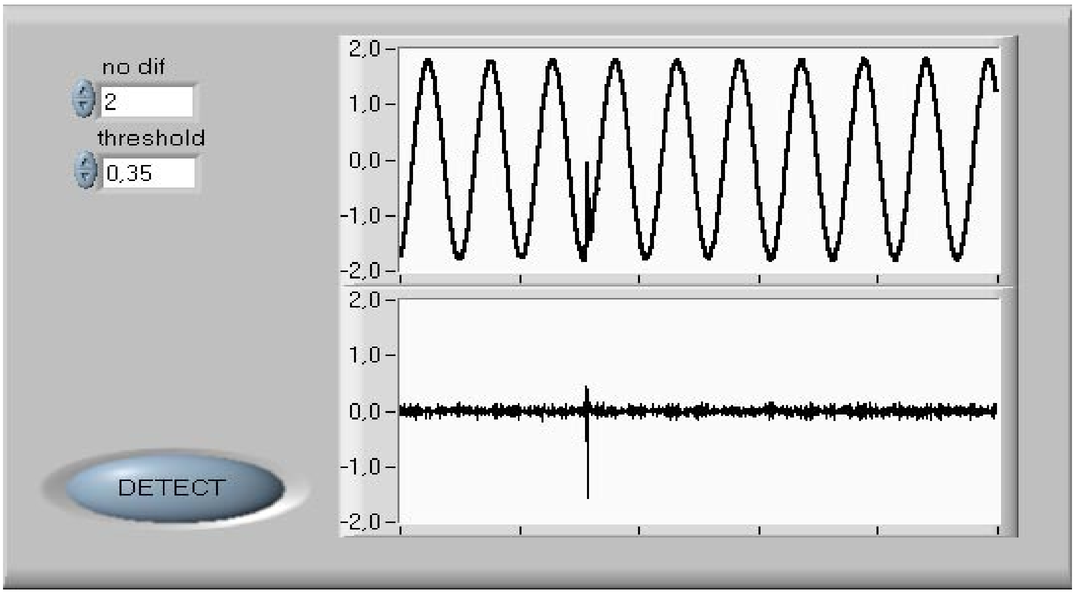

Fig. 7. Virtual instrument front panel

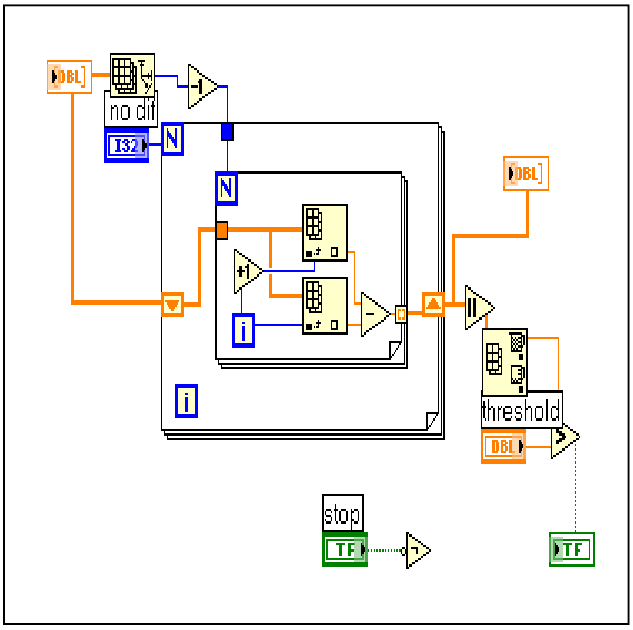

Fig. 8. Virtual instrument bloc diagram

A National Instrument data acquisition board (AT-MIO-16E-10 type) performs the communication between VI and system devices Several modules (subVIs) were developed in LabVIEW [6]in order to perform signal acquisition, data processing, data analysis, and results display functions. Each module can be programmed and executed independently. This modular design concept simplifies program debugging and improves its reusability. Finally, the VI presents a user-friendly graphical interface, by means of some very useful

3. CONCLUSIONS

The proposed paper describes a method for on-line detection of narrow transient events (spike) accidentally occurring in the voltage shape in electric power systems. The method consists of successive derivations of the signal till the only event remains significant in the sequence. The event detection is not influenced neither by the time variation of the signal parameters, nor by the presence of noise.

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Codrin Donciu : Technical University Gh. Asachi, Faculty of Electrical Engineering, 53 Mangeron, Iasi, Romania, Ph.: +40-32-278683, E-mail: cdonciu@ee.tuiasi.ro
Cristian Fosalau : Technical University Gh. Asachi, Faculty of Electrical Engineering, 53 Mangeron, Iasi, Romania, Ph.: +40-32-278683, E-mail: cfosalau@ee.tuiasi.ro
Mihai Cretu : Technical University Gh. Asachi, Faculty of Electrical Engineering, 53 Mangeron, Iasi, Romania, Ph.: +40-32-278683, E-mail: mcretu@ee.tuiasi.ro