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DIGITIZATION OF OSCILLOGRAMS BY RASTER IMAGES FOR RISING OF ACCURACY AT SIGNAL PARAMETERS DETERMINATION

Abstract. Digitization method of analog oscillograms by the raster images was investigated as a tool for rising of accuracy at signal parameters determination. As was shown, the raster images of oscillograms at determining signal time parameters allow providing the measurement accuracy on a level of digital frequency meters.

Key words: digitization, raster image, analog oscillogram, time parameters of signal.

Introduction. Raster images are an effective method for digitization of experimental data obtained in the image form. Microscopy data, the oscillograms obtained by analog oscilloscope, the satellite images and other relate to such data. For digitization of experimental image it is necessary to take a picture by a digital camera. As was shown in [1], the relative error at determining instantaneous voltages may be lower ± 1.5% if to use a raster image of oscillogram obtained by the analog oscilloscope. Processing of experimental data obtained in the form of raster image is performed by scanning of the necessary coordinates for a studied object. Parameters of object can be calculated by scan coordinates using the scale factors determined previously. These scale factors can be found by scanning of the calibration signal or by scanning of the length scale. Scanning can be performed at using graphics editors or specific programs [2].

Problem statement. The aim of present work is a comparative analysis of the signals parameters found from the raster images of oscillograms obtained by analog oscilloscope and the same parameters measured by digital frequency meter Ч3 – 34.

Major part. The determining of object parameters in the raster image is based on coordinates scanning. If coordinates scanning is executed for two points of a raster image, then these coordinates allow de-

termining such parameters of object as the length, the instantaneous value of signal voltage, the duration of time interval. As it shown in [3], if we execute a scanning of coordinates for many points on the object border, then the object area can be determined.

First of all it is necessary to define the scale factor M_C for a calculation of the object parameters by scanned coordinates. Raster images containing the calibration voltage or the length scale can be used for this aim. If perform a scanning of coordinates at the ends of such intervals ($x1_C$; $y1_C$; $x2_C$; $y2_C$), then M_C can be found as

$$M_C = L_C / \left|\sqrt{(x1_C - x2_C)^2 + (y1_C - y2_C)}\right|, \quad (1)$$

where L_C is a value of calibration voltage, length scale or calibration time interval.

In this work for determining the signal time parameters (frequency, period and duration) were used the raster images of analog oscillograms. These oscillograms were registered by means of oscilloscope С8 – 11. Raster images of oscillograms were obtained by means of the digital camera “OLYMPUS”. For a comparative analysis of the signal parameters obtained from the raster images same parameters were measured by means of frequency meter Ч3-34.

The calibrated rectangular pulse with duration L_{CT} = 577.3 μs was used for determining the time scale M_{CT} (Fig.1). Scanning of a pulse fronts on the level of 0.5 amplitude allows defining the value M_{CT} = 0.4567 μs/pixel for the given sweep of oscilloscope. This oscilloscope sweep was saved at the oscillograms registration for all signals investigated in the present work.

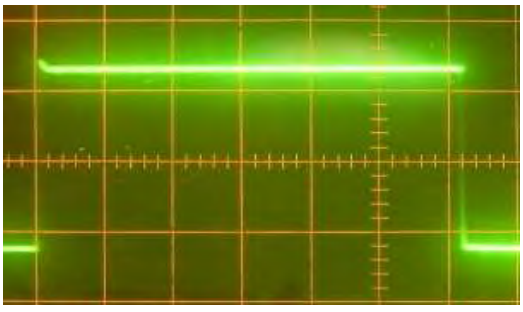

Figure1 - Raster image of the calibrated rectangular pulse

For determining the signal time parameters, a scanning of the oscillogram raster images was performed by means of the program de-

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scribed in [2]. Scan was executed along the oscilloscope time axis in two points corresponding to a period or duration of investigated signal.

From the scanning data a value of the time interval Δt is defined as

$$\Delta t = M_{CT} \cdot |x1 - x2|, \qquad (2)$$

where x1 and x2 are coordinates in pixels for the interval ends. These coordinates must be obtained at y1 = y2.

It should be noted, that the absolute error in scanning of the raster images amounts ± 1 pixel. If a thickness of line for oscillogram is identical in a range of oscilloscope display and has the clearly defined edges, then the absolute error in determining the interval length by raster image must be about ± 2 pixels. In this case the relative error δ_T can be found on the basis of equation (2) as

$$\delta_T = \pm \frac{2}{|x1 - x2|} \cdot 100\%. \qquad (3)$$

As it follows from the eguation (3), the relative error in determining of a time interval is decreasing inversely with increasing of the interval length |x1 − x2|. The value |x1 − x2| in pixels must be greater for digital photo cameras with a greater resolution for a same interval Δt. Therefore application of photo cameras with a greater resolution for obtaining the raster images of analog oscillograms reduces the relative error in determining of time intervals too.

Fig. 2 shows the window of program used for scanning of oscillograms in the raster image [2].

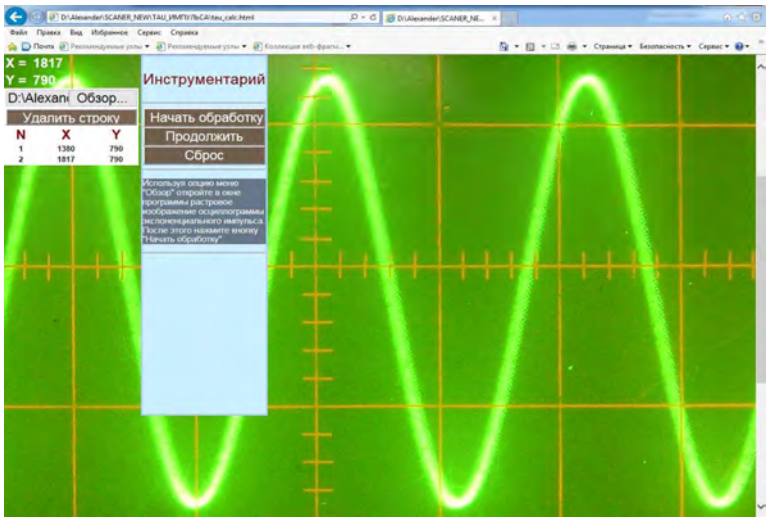

Figure 2 - Window of program with the scanning data of sinusoidal signal

For a signal shown in the Fig. 2, the relative error in determining of period by the scan data is equal ± 0,2%, as it was obtained from the equation (3).

The time parameters for different signals tested in the present work were measured by means of the frequency meter Ч3 – 34. Table 1 shows a comparison of signals parameters calculated from the scan data of oscillograms in raster image and the same parameters measured by a frequency meter. The "Deviation" columns show the deviations (in percents) for parameters measured by a frequency meter and the same parameters obtained at using the raster images of oscillograms. This deviation no more than 1 %, as it can see from the table 1.

Table 1

Comparative table of the signal time parameters

Period, μs		Deviation %	Frequency, kHz		Deviation %	Duration, μs		Deviation %	Type of signal
Ч3-34	Raster image		Ч3-34	Raster image		Ч3-34	Raster image		
–	494.6	–	2.003	2,022	+0.95	–	–	–	Sinusoidal
–	199.6	–	4.991	5,011	+0.40	–	–	–	Sinusoidal
–	99.41	–	10.052	10,06	+0.08	–	–	–	Sinusoidal
–	71.20	–	14.006	14,04	+0.23	–	–	–	Sinusoidal
–	59.92	–	17.856	17,89	+0.19	–	–	–	Sinusoidal
–	–	–	–	–	–	293.7	296.4	+0.92	Rectangular pulse
191.4	191.8	+ 0.21	5.219	5.214	–0.10	71.40	71.21	–0.28	Rectangular pulse

Conclusions. The raster images of analog oscillograms allow determining the signal time parameters with the accuracy close to accuracy of a digital frequency meter.

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