DOI 10.34185/1562-9945-1-138-2022-12
UDC 004.42

A.I. Ivon, V.F. Istushkin, Yu.V. Krikunenko

WEB APPLICATION FOR RESEARCHING THE BRIGHTNESS DISTRIBUTION OF PIXELS IN DIGITAL IMAGES

Abstract. Web application (program) for testing the distribution of pixel brightness along the line segment specified by user on a digital image is described. The application was created using the languages HTML5, CSS3, JavaScript and the Canvas technology. Investigations of the pixels brightness distribution of digital images of analog oscillograms were performed. On the basis of these investigations the criteria necessary for organizing automatic (software) scanning of the oscillograms digital images at measuring the parameters of electric signals were determined.
Keywords: digital image, RGB code, determination of parameters by scan data.

Statement of the problem and purpose of research. As shown in [1, 2], the use of digital images of analog oscillograms allow significantly increase the accuracy of measuring the parameters of electrical signals. The relative error in measuring of instantaneous voltages and time intervals at using the digital images of analog oscillograms has a value no more ±2%, as in digital oscilloscopes and frequency meters [1]. This is due to the fact that the absolute error of coordinates scan of digital image objects does not exceed ± 1 pixel. Therefore at high resolution of a digital photo camera used to obtain the images of analog oscillograms, it is possible to ensure high accuracy in measuring of the electrical signals parameters when for processing of such images use applied web applications [1, 2]. The algorithm for processing of digital images consists in scaling them using the scan data of the calibration signals, and calculating the measurable parameter, based on the scan data of image with oscillogram of the tested signal and the scale of this image.

Scanning of a digital image can be performed manually by click of the left mouse key in selected point or automatically by the programmatic way. The criterion for selecting the scanning point by programmatic way can be color or brightness of pixel. In automatic scanning of digital images of analog oscillograms the scanning criterion can be the brightness of pixel, since the pixels located in the center of oscillogram line have the maximum brightness.

© Ivon A.I., Istushkin V.F., Krikunenko Yu.V., 2022

In this regard, the aim of this work is to create an applied web application for testing the brightness of pixels of a digital image, which allows you to build the distribution of pixel brightness along the line selected in the image and determine the pixel with maximum brightness in this distribution.

Major part. For creation of web application the languages HTML5, CSS3, JavaScript and Canvas technology were used. To obtain information about RGB code of pixels in scripts of web application the ImageData object [3] was used. Information about the contribution of the basic colors (red, green, blue) to the RGB code was obtained using the properties "data [0]", "data [1]" and "data [2]" of this object. The pixel brightness value was calculated as the sum of contributions of the base colors. The distribution of pixels brightness was recorded along a segment of vertical straight line with thick of 1 pixel drawn by pressing the left key of mouse. The scripts of program serving this stage of digital image processing register the coordinates of the one end of line segment (x_b, y_b) by the "mousedown" event, and the coordinates of other end (x_b, y_e) by the "mouseup" event.

The getImageData() method was used to scan the basic components of RGB code of pixels. This method with "data []" properties is used in script that scans the components of RGB code of pixels. This script organizes a loop with step of 1 pixel along a segment of vertical line bounded by points with coordinates (x_b, y_b) and (x_b, y_e). Based on the scan data, it calculates the brightness of each pixel for this segment. The values of y-coordinate and the corresponding to they brightness of pixels save into arrays of program. This data is used to draw a brightness distribution curve on the image embedded in canvas by means of the Canvas technology.

Taking into account the above, the web-application for studying the brightness distribution of pixels in digital images realizes an algorithm consisting of the following stages: 1). Loading the digital image of analog oscillogram into a browser window and embedding it into canvas; 2). Drawing a vertical line segment along which the brightness distribution is investigated; 3). Scanning the RGB code of the pixels on this segment and calculating their brightness; 4). Building the brightness distribution along the selected segment of line.

In fig. 1 shows the view of the application web page at the final stage of implementation of the above algorithm.

ISSN 1562-9945 (Print)
ISSN 2707-7977 (Online)

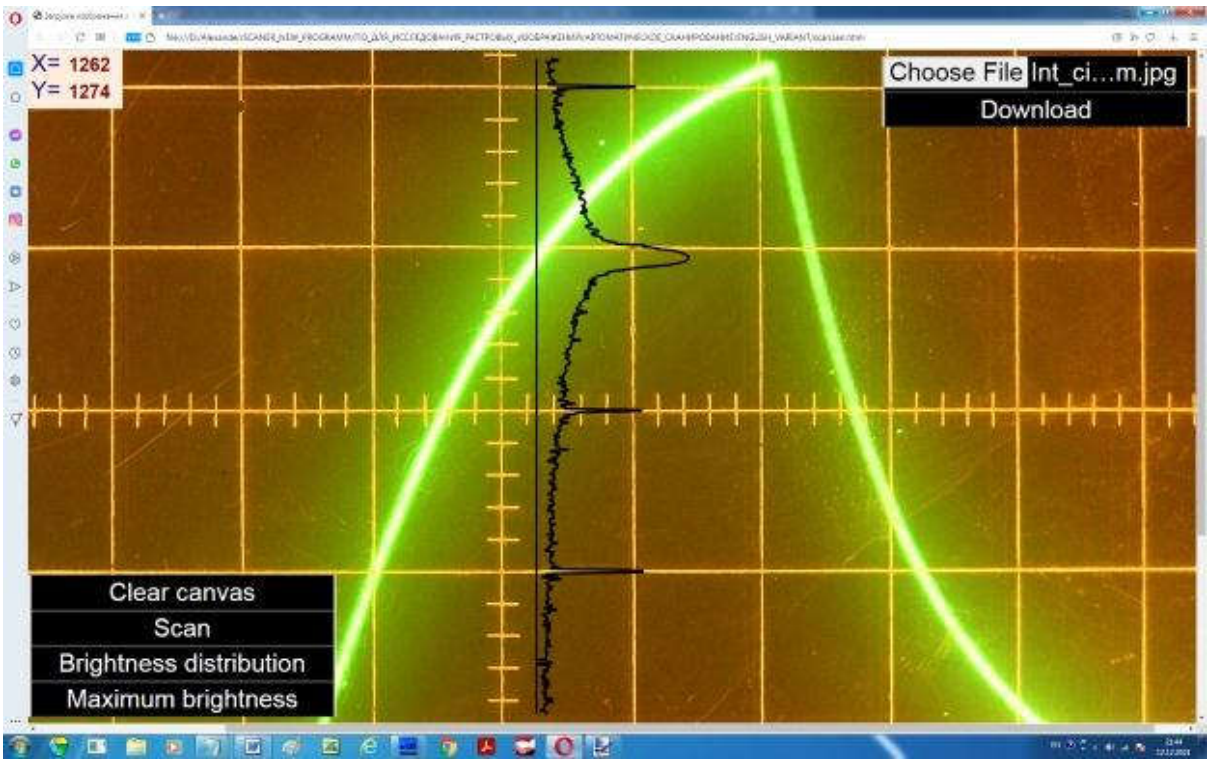

Figure 1 - Web-page of the application with the brightness distribution curve along the segment of vertical line highlighted in the digital image

The web application interface has a toolbox containing form fields and buttons (Fig. 1). For implement vector graphics using the tag <canvas>, a canvas has dimensions of 2300×1750 pixels was created. The canvas is positioned absolutely and has indent of 0 pixels from the left and top sides of browser window. Tag <canvas> contains three event handlers. The event handler “onMousemove” initiates the script to indicate the current coordinates of the cursor and display them in the hidden form fields of the block located in the upper left corner of the browser window (Fig. 1). The event handler “onMousedown” runs a script that registers the coordinates (x_b, y_b) of the upper end of the vertical line segment and the event handler “onMouseup” runs a script to register the coordinates (x_b, y_e) of its lower end. For read the cursor coordinates these scripts use the properties “pageX” and “pageY” of the “event” object.

In the upper right corner of the browser window there is a block with a “file” form field and a “Download” button. The “file” form field is used to select a graphic file of digital image in the computer’s file system and load it into the browser window. The tag <input> that creates this field has the event handler “onchange” that runs the web application script for loading the image into the browser window. This script uses the methods and properties of the object FileReader for this purpose. For

embedding the image into canvas the Download button is used. When this button is pressed a script executes that embeds the image into canvas using the method drawImage().

In the lower left corner of the browser window there is a toolbox for scanning the RGB code of pixels, plotting the distribution of pixel brightness and determining the coordinates of the pixel with maximum brightness.

The scanning of RGB code along the line segment selected by user carries out when the "Scan" button is pressed. At pressing the button "Brightness distribution" a script is executed that draws in black color the line segment selected by user and the relative brightness distribution along its using the means of Canvas (Fig. 1). This script calculates the values of relative brightness *rbr* for each pixel in the line segment using the formula:

$$rbr = \frac{300 \cdot (br - br_{\min})}{br_{\max}}, \quad (1)$$

where *br* is the current value of the brightness for pixel lying on the line segment, br_{min} is the minimum value; br_{max} is the maximum value of the brightness for pixels in the scanning range $y_b \le y \le y_e$. The multiplier 300 in formula (1) defines the length of horizontal line segment of 300 pixels along the X-axis of canvas. The relative brightness is needed to plot the brightness distribution curve on canvas described by the function *rbr = f(y)*, where argument is the *y* coordinate of canvas, and the value of relative brightness is displayed in pixels along the *x* coordinate of canvas (Fig. 1).

As seen in Fig. 1, in the scanning range $y_b \le y \le y_e$, the largest values of brightness have pixels lying on the line of signal oscillogram. Among them is the pixel with maximum brightness. Its coordinates $x_{max}=xb$ and y_{max} correspond to the instantaneous value of signal voltage at the time point determined by the x_b coordinate. The script running when the "Maximum brightness" button is pressed defines the coordinates (x_{max}, y_{max}) using the br_{max} relative brightness value. It draws a horizontal segment with length of 300 (br_{max} - br_{min})/br_{max} pixels from a point with coordinates (x_{max}, y_{max}). These coordinates open in the upper left corner of browser window (Fig. 2).

ISSN 1562-9945 (Print)
ISSN 2707-7977 (Online)

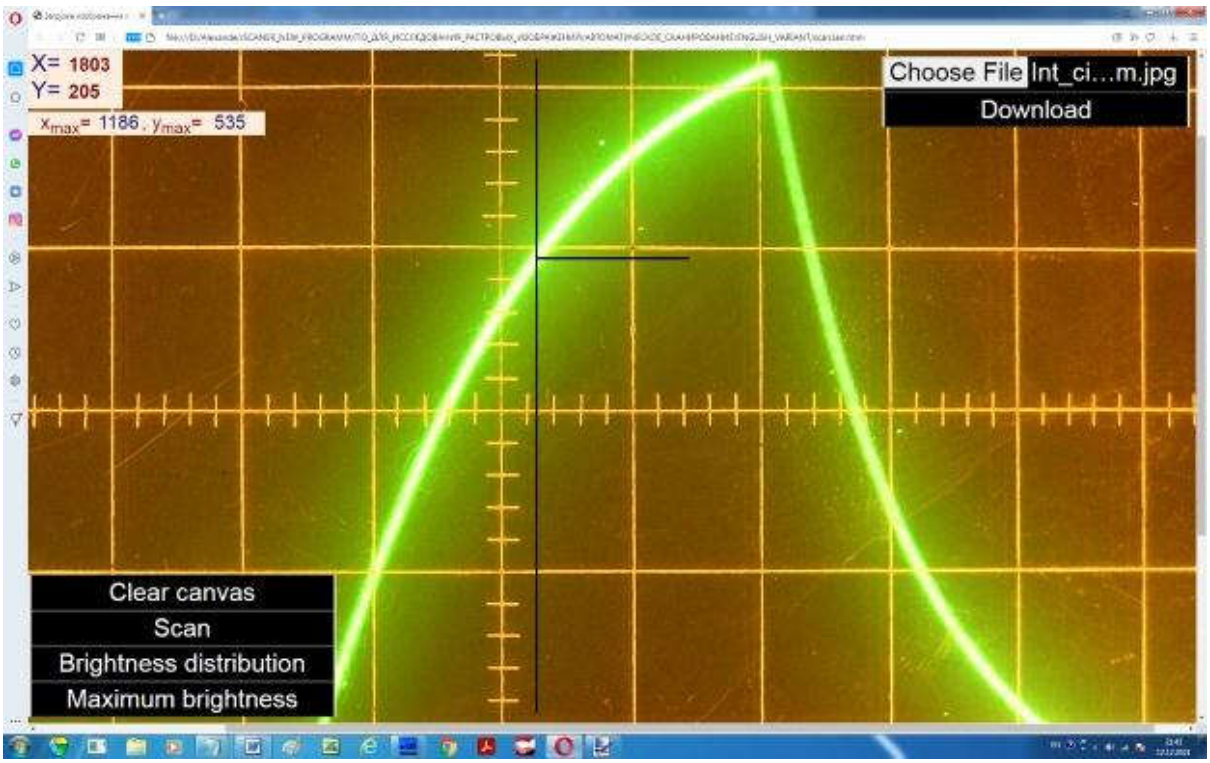

Figure 2 - Web page of the application after selection of the brightest pixel in scan interval. This pixel has selected by the programmatic way

Thus, the scripts of web application described above can be used to organize automatic (programmatically) scanning of digital images of analog oscillograms at measuring the parameters of electrical signals. Criterion for the programmatically selection of digital image points corresponding to instantaneous voltage values on the line of signal oscillogram at scanning of pixel RGB code is the maximum brightness of a pixel lying on a vertical line of 1 pixel thick crossing the oscillogram line.

Conclusions. Using the HTML, CSS, JavaScript languages and the Canvas technology, a web application (program) for testing the distribution of pixel brightness along the line segment specified by user on a digital image has been created. The program allows the user to create a segment of straight line along which the brightness distribution is registered, it determines the coordinates of points in which the brightness has maximums and builds a spectrum of brightness. The program has spectrum filtering tools that leave the lines with the highest brightness. The user can set the number of such spectrum lines at his own discretion.

The studies of brightness spectrum for digital images of analog oscillograms have been performed. Based on these studies, the criteria for choosing pixel coordinates for organizing automatic (software) scanning when measuring the parameters of electrical signals by digital images of oscillograms were determined.

REFERENCES

1. Ivon A.I., Istushkin V.F. Digitization of oscillograms by raster images for rising of accuracy at signal parameters determination / System technologies. 2017, issue 1 (108), p. 37-40.

2. Ivon A.I., Istushkin V.F. Software for processing digital images of analog oscillograms / System technologies, issue 1 (90), p. 10-17.

3. David Geary. Core HTML5 Canvas: Graphics, Animation, and Game Development. – Prentice Hall, 2012, 752 P.

Received 17.01.2022.
Accepted 21.01.2022.

Web застосунок для дослідження розподілу яскравості пікселів цифрових зображень

Описано прикладний web застосунок (програму), призначений для тестування розподілу яскравості пікселів растрових (цифрових) зображень вздовж відрізка прямої лінії заданого користувачем. Застосунок створено засобами мов HTML5, CSS3, JavaScript і технології Canvas. Робота програми починається завантаженням растрового зображення до вікна браузера, файл якого користувач обирає у файловій системі комп'ютера. Для завантаження зображень використані методи і властивості об'єктів FileList, File, FileReader та Image мови JavaScript. Для реєстрації внеску базових компонентів (червоної, зеленої і синьої) до RGB коду кольору пікселів використані метод getImageData() і об'єкт ImageData. Яскравість пікселя визначається як сума вкладів базових компонентів RGB коду.

Програма надає користувачу можливість задати відрізок прямої лінії, вздовж якого реєструється розподіл яскравості. Це здійснюється шляхом натискання клавіші миші в точці зображення, що відповідає початку відрізку і відпускання клавіші в точці на кінці відрізку. Програма визначає координати точок вздовж лінії сканування, яким відповідають максимуми яскравості і будує спектр яскравості. Вона має засоби для фільтрування спектру, які залишають ліній з найбільшою яскравістю. Кількість таких ліній користувач може задати на своє розуміння.

Виконані дослідження спектру яскравості цифрових зображень аналогових осцилограм, на підставі яких визначені критерії вибору координат пікселів для організації автоматичного сканування при вимірюванні параметрів електричних сигналів з цифрових зображень аналогових осцилограм.

ISSN 1562-9945 (Print)
ISSN 2707-7977 (Online)

Івон Олександр Іванович – доктор фізико-математичних наук, професор, професор кафедри електронних обчислювальних машин, Дніпровський національний університет ім. О. Гончара.

Істушкін Валерій Федорович – кандидат технічних наук, доцент, доцент кафедри електронних обчислювальних машин, Дніпровський національний університет ім. О. Гончара.

Крикуненко Юлія Вадимівна – студентка групи КІ-20м-1 факультету фізики, електроніки та комп'ютерних систем, Дніпровський національний університет ім. О. Гончара.

Ivon Alexander Ivanovich - doctor of physical and mathematical sciences, professor, professor of the department of Electronic Computing Machinery, Oles Honchar Dnipro National University.

Istushkin Valery Fedorovich - candidate of technical sciences, associate professor, associate professor of the department of Electronic Computing Machinery, Oles Honchar Dnipro National University.

Krikunenko Julia Vadimovna - student of the group KI-20m-1 of the faculty of Physics, Electronics and Computer Systems, Oles Honchar Dnipro National University.