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WEB APPLICATION FOR MEASUREMENT OF THE SIZES AND AREA OF OBJECTS BY SATELLITE PHOTOGRAPHY

Abstract. A web application is described that allows measuring on a basis of scan data the sizes and area of objects in the satellite photographs. At creation the web application were used the software tools for client web applications: HTML5, CSS3, JavaScript and Canvas technology. The application can be used on client computers to measure the geometrical parameters of objects of satellite photographs, as well as can be placed on websites are devoted to the processing of such photographs.

Keywords: web application, satellite photography, scanning, determination of parameters by scan data.

Formulation of the problem. Satellite photographys are the raster (digital) images. The carriers of digital information in such images are pixels. Each pixel has the coordinates (x_i, y_i) defined relative to the upper left corner of image and a color represented as a 24-bit binary RGB code, usually [1].

The image scale information is presented in satellite photographs as an interval of known length L_C. Having determined the coordinates of the ends of such interval (x_{L1}, y_{L1}; x_{L2}, y_{L2}), one can find the scale M_L of the satellite photograph as $M_L = L_C / \sqrt{(x_{L1} - x_{L2})^2 - (y_{L1} - y_{L2})^2}$. Knowledge of the scale makes it possible to measure the geometrical parameters of objects represented in the satellite photography: size, path length, area. Such measurements can be performed by scanning the coordinates of points (pixels) appurtenant to the object and subsequent calculation on the basis of these data and scale M_L of the required geometric parameters.

In order to obtain the above information, special software is required for the processing of satellite images. In particular, such software can be created by the basic tools for creation of the client web applications for the Internet. This makes it possible to use browsers as a software environment for such applied web applications and place them on Internet sites.

Purpose of the research. Taking into account the foregoing, the purpose of this work is creation of web application for the measurement on the basis of scan data the sizes and area of objects in satellite photographs.

If the scale M_L, of satellite photograph is known, then the distance L between two points in this photo with coordinates in pixels (x_1, y_1) and (x_2, y_2), can be calculated by the formula:

$$L = M_L \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \ . \quad (1)$$

The degree of discretization (quantization) of a satellite photo determines the resolution given in pixels. Therefore, the scale M_L, showing how many units of the length corresponds to one pixel is an absolute error in measuring of the length associated with the discretization of the satellite photograph. The value of M_L determines in units of length, the uncertainty of the position of the two ends of the line connecting the points with coordinates (x_1, y_1) and (x_2, y_2). Therefore, the absolute quantization error at calculating of the length is $\Delta L_{qu} = \pm 2 M_L \Delta$, where $\Delta = 1$ pixel.

If it is necessary to determine in any direction the length of the object of satellite photography, then it is necessary to perform the scanning in this direction the coordinates of two points lying on the borders of the object. In this case the blurriness of line of the object boundary gives an additional error. The points for scan should be selected in the middle of this line. If the blurriness of line is not very large, the error in the choice of the scan points is about $\pm$ 1 pixel. This gives an additional absolute error in determining the distance L. This error one can be estimated as $\Delta L_{bl} = \pm 2 M_L \Delta$, где $\Delta = 1$ pixel. Therefore, taking into account the errors of quantization and blurring of the object boundaries in satellite photo, formula (1) can be represented as:

$$L = M_L \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \pm 4 M_L \Delta \, , \quad (2)$$

where the absolute error $\Delta L = \Delta L_{qu} + \Delta L_{bl} = \pm 6 M_L \Delta$ ($\Delta = 1$ pixel).

At measurement of the path length L_{path} by means of satellite photography, it is necessary to scan the coordinates of points (pixels) along this path. Such scan gives the coordinate arrays x_i, y_i $(1 \le i \le N)$. The sum of straight line segments connecting adjacent points to a certain extent reflects the length of path, since in this case the real path is replaced by a broken line (Fig. 1). It should be noted that at a sufficiently large number of coordinates of points N, the length of broken line will be close to the actual path length. Therefore, in the future at estimating of the absolute error at measurement of path length by satellite photography, we will not take into account deviation of the straight line that connects the adjacent scan points from

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the real curve of the path line. In this case the path length, taking in account (1), may be calculated by the formula:

$$L_{path} = \sum_{i=1}^{N-1} L_i = M_L \sum_{i=1}^{N-1} \sqrt{(x_i - x_{i+1})^2 + (y_i - y_{i+1})^2} \ . \quad (3)$$

Since the path line has two ends, the position of which is not defined within the range $\pm 2M_L\Delta$, due to the quantization error and the blurring of objects boundaries, the absolute error in measurement of the path length ΔL_{path} can be estimated as

$$\Delta L_{path} = \pm 4M_L\Delta \quad (4)$$

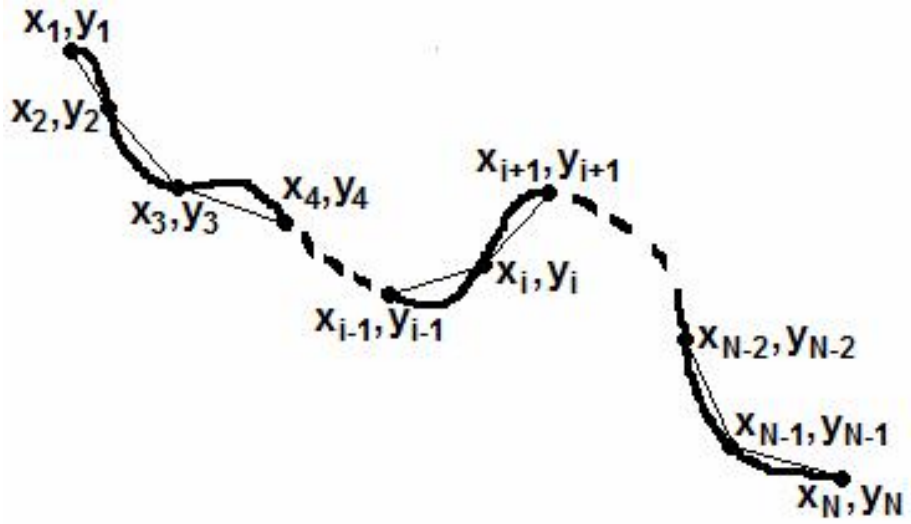

Figure 1 - The real path of satellite photography (bold line) and broken line (thin line) with the scanned coordinates x_i, y_i $(1 \le i \le N)$

Determining the area of an object of satellite photography on a basis of scan data can be performed by calculating the area of polygon with vertexes of angles on a contour line that covers the area of object. As known [2], the area S of the polygon can be found on a basis of coordinates of its angles by the Gauss formula:

$$S = \frac{M_c^{\,2}}{2} \left| x_N y_1 - x_1 y_N + \sum_{i=1}^{N-1} (x_i y_{i+1} - x_{i+1} y_i) \right| . \quad (5)$$

If we do not take into account the deviation of the real contour line covering the area of the object from the broken contour line corresponding to the scan data, then at determining S, the basic error is associated with the absolute error of the length quantizing $\pm M_L\Delta$ (Δ = 1 pixel). In this case the absolute error in measurement of the object area can be estimated as $\Delta S = \pm M_L\Delta P$, where P is the perimeter of the broken contour line. Considering the above, for the absolute error in determination of the objects area by satellite photography, we can get the following evaluation expression:

$$\Delta S = \pm M_c^2 \left(\sqrt{(x_1 - x_N)^2 + (y_1 - y_N)^2} + \sum_{i=1}^{N-1} \sqrt{(x_i - x_{i+1})^2 + (y_i - y_{i+1})^2} \right). \quad (6)$$

The above formulas were used to the calculation of the geometrical parameters of objects of satellite photos in the web application is presented in this work. The application performs the following processing stages: 1). Loading of satellite photo into the browser window; 2). Scaling; 3). Scanning coordinates of the measured object; 4). Calculation of the object geometric parameters; 5). Output of results.

The application is created by means of languages HTML5, CSS3 and JavaScript. Application uses Canvas technology for displaying measured path and line of the contour covering the area of measurable object in satellite photos. The processing stages on the web page of application are implemented as separate blocks with the necessary set of form fields and buttons. The execution of scripts serving the block occurs at the button is pressed when the event of *click* takes place. The blocks in the HTML file of web application are created using the </ div> tag. Controlling of their display, in accordance with the sequence of processing stages, is carried out in scripts by the property *visibility* of the *style* object.

Fig. 2 shows the web page of application at the final stage of processing at measurement of path length. The path is displayed by the line of white color. The centers of small circles with a radius of 2 pixels on this line correspond to the points of satellite photograph where the scanning was performed. For drawing lines and circles the appropriate Canvas means were used. Access to these means is provided by the canvas of 2300×1550 pixels which is the web page element created by means of tag <canvas>. The satellite photography is located inside the canvas. The <canvas> tag contains event handlers of *onMousemove* and *onMouseup*. The *onMousemove* event handler initiates a script that allows user to see the current coordinates of the mouse cursor. These coordinates are displayed in the block located in the upper left corner of web page (Fig. 2). The coordinates are scanned by pressing the left mouse button at the selected point of the satellite photograph. In this case, the event handler of *onMouseup* initiates the script, which, using the *pageX* and *pageY* properties of the *event* object, reads the coordinates of point and writes them into arrays of the scan data.

Figure 2 - Web page of the application at final stage of the measurement of path length by satellite photography

The blocks for the various stages of satellite photo processing are located in the upper right corner of web page. The image loading block contains a form field of "file" type with the "Select a file" button (Fig. 2). This field allows selecting the graphic file of satellite photo stored in computer and uploads it to a web page. Loading occurs on the *change* event by means of script that uses the *target* property of the *event* object and properties and methods of the *FileReader* object. For transfer the satellite photo from web page on canvas, the "Dowload" button is used. At this button pressing a script is executed, which puts image on canvas by method *drawImage()*.

At press on the "Scaling" button opens block for the stage of scaling. This block contains a form field of the "radio" type to select a unit of length (meters or kilometers), form field for the input of calibration interval L_C, and the button "Calculate scale". At pressing the button, script calculates the scale of the satellite photo M_L, after selecting unit of the length, the input of value of L_C and scanning the ends of the calibration interval. The value M_L is stored in a global variable and is available for all scripts of web application.

Block for measurement of the sizes and the path length in satellite photo is opened when a click on the "Length measurement" button takes place (Fig. 2). The calculation of parameters on a basis of scan data for object in satellite photo by the

formulas (3), (4) occurs when the “Calculate length” button is pressed. The measurement results are displayed in hidden fields of forms in the block.

Block for measurement of the objects area of satellite photography is opened by a click on the "Area measurement" button. It is organized in the same way as a block for measurement of the length. Fig. 3 shows the web page of application at final stage of the object area measurement. The calculation of the area on a basis of scan data by formulas (5), (6) is carried out at a click on the “Calculate area” button.

The “Clear” button is provided in the processing block of web application. Clicking this button clears the scan data and the fields of result in forms, erases the lines and circles drawn on the canvas. At the same time, the scale value of satellite photo is preserved. This makes it possible, bypassing the scaling stage, to begin a measurement of geometrical parameters for other objects of satellite photography.

Conclusions. By means of HTML5, CSS3, JavaScript languages and Canvas technology the web application has been created for the measurement of sizes and area of the objects in satellite photo. The values of sizes and area are determined on the base of scan data of objects. The measurement absolute error related whith quantization and blurring of the object boundaries was calculated. The application can be used on client computers, as well as posted on websites dedicated to processing satellite photographies.

Figure 3 - Web page of the application at final stage of the area measurement by satellite photography

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