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IMAGE CONSTRUCTION TO AUTOMATION OF PROJECTIVE TECHNIQUES FOR PSYCHOPHYSIOLOGICAL ANALYSIS

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Abstract. The search for a solution of automation of the process of assessment of a psychological analysis of the person drawings created by it from an available set of some templates are presented at this article. It will allow to reveal more effectively infringements of persons mentality. In particular, such decision can be used for work with children who possess the developed figurative thinking, but are not yet capable of an accurate statement of the thoughts and experiences. For automation of testing by using a projective method, we construct interactive environment for visualization of compositions of the several images and then analyse.

Keywords: affine transformation; geometric and colorimetric image conversion; interactive graphic editor; projective techniques.

Introduction. In the modern world we can see the development of computer psychodiagnostics, which is associated with fundamentally different capabilities (adaptive testing, time as a factor in the experiment, virtual reality, gaming motivation) offered by the use of computers.

There are many techniques and methods of psycho-diagnostics, which can serve as a separate tool or to complement each other. Stop your attention on projective techniques [1-2]. These techniques cause the ambiguity of many specialists. On the one hand they are more informative than many of the questionnaires and tests, and with another – are difficult to interpret.

For today, there is no unanimity on the interpretation of the results of psychographic research [3]. This fact significantly reduces the possibility of psycho-diagnostic use of graphical techniques, and inhibits their development, enrichment and verification.

For making the process of interpretation easiest, was offered the creation of the graphics editor in which it would be possible to implement some templates of diagnostic criteria for automation of the process of interpretation the test results.

Materials and Methods. In the development of information system for automation of testing by using a projective method, there arises the problem of constructing interactive on-screen visualization of the composition of several images. This task can be divided into two parts – the geometric and colorimetric image conversion [4-7]. The first part determines the position of each component image on the screen, and the second is the interaction of images at their mutual overlap.

The simplest geometric transformation of the image determines the shift of the image relative to the center of the screen, or any other selected on-screen reference points, the scale and rotation relative to some point. In fact, these transformations are the projection of image plane onto the plane of the screen. To perform the above transformations offers are considered in [8] of the affine coordinate conversion, which can be specified as follows:

$$\begin{aligned}x_{im} &= A_x x_s + B_x y_s + C_x \\y_{im} &= A_y x_s + B_y y_s + C_y\end{aligned}\quad (1)$$

where (x_{im}, y_{im}) - the coordinates of the point image in the coordinate system of the image that will be displayed at the point of screen coordinates (x_s, y_s) in the coordinate system of the screen s (*screen*); $A_x, B_x, C_x, A_y, B_y, C_y$ - the coefficients of the affine transformation.

The main characteristics of the proposed conversion is the preservation of parallelism of line segments, connecting the same point source and obtained after transformation of the image and ease of implementation. The first property makes it easy to find the coefficients of affine transformation by setting the condition of the three, defining a plane of the original image pixels on the screen, and the second gives the relative independence from the computing power of a processor, which included in the information system.

To use relations (1) it is necessary to find the values of affine coefficients that determines the position of the original image on the screen. From this relation it is seen that the coefficients C_x and C_y determine the displacement of the image relative to the screen origin, A_x and B_y - are the scale, B_x and A_y - linear shift corresponding to the coordinate axes. However, despite the obvious sense of affine coefficients, the implementation of the complex geometric transformation of the image requires taking into account the mutual influence of these coefficients and additional calculations.

Using the above-mentioned property of the transformations (1), the affine coefficients can be obtained by solving two systems of linear equations three variables:

$$\begin{cases} x_s[1] \cdot A_x + y_s[1] \cdot B_x + 1 \cdot C_x = x_{im}[1] \\ x_s[2] \cdot A_x + y_s[2] \cdot B_x + 1 \cdot C_x = x_{im}[2], \\ x_s[3] \cdot A_x + y_s[3] \cdot B_x + 1 \cdot C_x = x_{im}[3] \\ x_s[1] \cdot A_y + y_s[1] \cdot B_y + 1 \cdot C_y = y_{im}[1] \\ x_s[2] \cdot A_y + y_s[2] \cdot B_y + 1 \cdot C_y = y_{im}[2], \\ x_s[3] \cdot A_y + y_s[3] \cdot B_y + 1 \cdot C_y = y_{im}[3] \end{cases} \quad (2)$$

where $(x_s[i], y_s[i]), i = \overline{1..3}$ - point coordinates of the screen in which will be projected reference point of the source image with coordinates $(x_{im}[i], y_{im}[i]), i = \overline{1..3}$. Given the system of equations will always have a solution, if chosen on the original image reference points are not collinear, that is, clearly define the plane of the original image.

The system of equations (2) can be solved by any known methods. As reference points of the reference image, it is advisable to choose distant from each other points, which will increase the accuracy of calculation of the affine coefficients.

It should be noted that, despite the simplicity of most of the geometric operation of projection images on the plane of the screen, complexity is the task of the parameters of this operation using the input devices present in the information system. This difficulty is that users of such a system, which are the medical professionals and patients, mostly poor guide to geometric concepts. Therefore, the interface set the parameters of geometric transformations of the images should be simple and obvious manipulation of input devices, such as capturing, dragging, mouse wheel, etc.

Results. Consider figure 1, which shows a geometrically transformed image with the original size of W_{im} to H_{im} points.

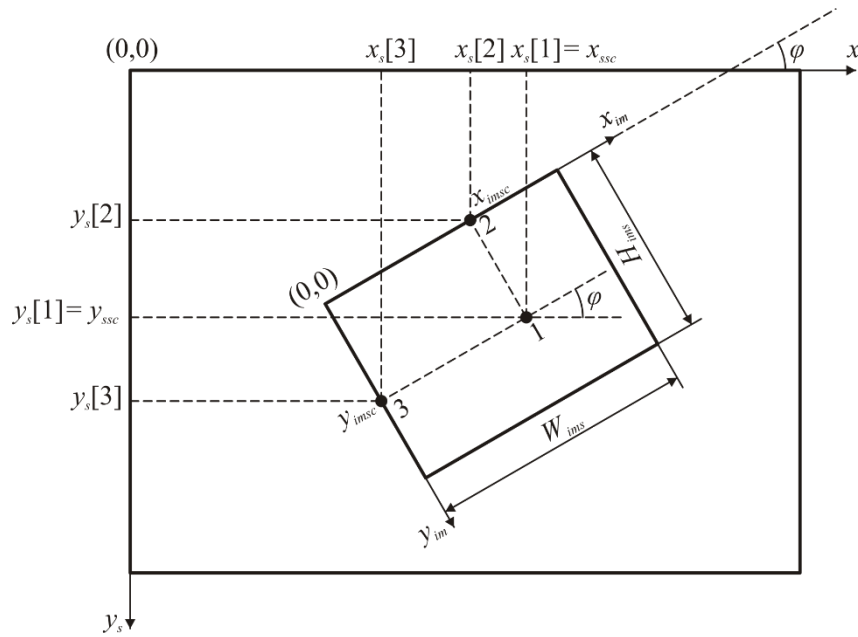


Fig. 1. Geometric transformation of image

On the screen this image is submitted with some large-scale coefficient of m . The coordinate system for image is turned relative to the coordinate system of the screen on the angle φ . On the image are chosen three reference points:

$$\begin{aligned} x_{im}[1] = x_{imsc} & \quad x_{im}[2] = x_{imsc} & \quad x_{im}[3] = 0 \\ y_{im}[1] = y_{imsc} & \quad y_{im}[2] = 0 & \quad y_{im}[3] = y_{imsc} \end{aligned} \quad (4)$$

where the coordinates are in the coordinate system of the image.

Point 1 is the center of scaling and rotation - is a point 1 with the coordinates. This point in system of coordinates of the screen has coordinates:

$$x_s[1] = x_{ssc}, \quad y_s[1] = y_{ssc} \quad (5)$$

The dimensions of the image on the screen will be:

$$W_{ims} = m \cdot W_{im}, \quad H_{ims} = m \cdot H_{im}. \quad (6)$$

Except a point 1 on the image are chosen two more reference points - 2 and 3 with coordinates $(x_{imsc}, 0)$ and $(0, y_{imsc})$ respectively. From the figure 1 and expressions (5) we can see, that values of coordinates of these points in system of coordinates of the screen can be received as follows:

$$\begin{aligned} x_s[2] &= x_{ssc} - m \cdot y_{imsc} \cdot \sin \varphi, & y_s[2] &= y_{ssc} - m \cdot y_{imsc} \cdot \cos \varphi, \\ x_s[3] &= x_{ssc} - m \cdot x_{imsc} \cdot \cos \varphi, & y_s[3] &= y_{ssc} + m \cdot x_{imsc} \cdot \sin \varphi. \end{aligned} \quad (7)$$

Substituting (3), (4) and (7) in the system (2) we find the unknown coefficients of the affine transformation.

Thus, the position of the image on the screen, you can specify a set of the following parameters: center of scaling and rotation coordinates in two coordinate systems – image and screen, scale factor and rotation angle.

Center of scaling and rotation coordinates – this is the coordinates of pointer of the input device at the moment of start of any operations over image. The action over the image is determined by the active element of the input device. For example, if you press and hold the left mouse button the image is dragged across the screen, following the mouse pointer. When you rotate the mouse wheel - respectively the scale factor is changing. When you press and hold the right mouse button – sets the increment of the rotation angle of the image, is equal to the angle between the axis x of the screen and the vector, drawn from the center of scaling and rotation in the current point location of the mouse pointer.

It is necessary to emphasize the ease of implementation of the transformation (1) line-by-line analysis (scan) screen coordinates. Before the beginning of the scan sets the initial coordinate values $x_{im}^0 = C_x, y_{im}^0 = C_y$. At the beginning of the scan of each row the values of the coordinates are set

$x_{im} = x_{im}^0, y_{im} = y_{im}^0$. Further, when moving to the next point of the line is run increment of coordinate x_{im} и y_{im} at the values A_x and A_y corresponding. After ending of next line is run increment of the initial values of the coordinates x_{im}^0 и y_{im}^0 at the values B_x and B_y corresponding. Further, the process is repeated. Thus, transformation (1) can be implemented only by performing two elementary operations of addition for each point of the screen. This virtually eliminates the nomination of any computing power requirements of the processor of the information system.

Discussed in [8] colorimetric transformations of images for the implementation of projective techniques testing of interest is only the operation of mixing, which determines the interaction of several images at a given point of the screen. For two images, the operation of mixing is performed without loss of information may be represented in the form:

$$E_m(x, y) = (1 - k_1(x, y)) \cdot E_0(x, y) + k_1(x, y) \cdot E_1(x, y), \quad (8)$$

where $E_m(x, y), E_0(x, y), E_1(x, y)$ - the intensity of the particular color component, the resulting, background and foreground images corresponding, $k_1(x, y)$ - a function of the presence of the foreground image in the resulting image.

In emitting the imaging systems, which include monitors of different principle, the used additive colorimetric system in which the image is represented by a set of red $R(x, y)$, green $G(x, y)$ and blue $B(x, y)$ color components. The dependence of (8) must be implemented for each of the color component images.

To preserve the linearity of the mixing operation, the value of the function presence must lie in the interval $[0, 1]$. A value of 0 corresponds to complete absence of information on the overlay image at a given point of the screen, and the full presence of the background image. A value of 1 represents full presence information of the overlay image at a given point of the screen and the complete absence of background image.

For saving color scheme mixing images the function the presence of $k(x, y)$ is the same for all three color components. This function can be set in the image for each point, for example, the PNG format [9] and be continuous for all points in the image. In the first case provides much more opportunities for the

implementation of video effects, for example, the transparency of the glass. Description of the process of defining the functions of presence for the source of the images is beyond the scope of this work.

Existence of the presence function is useful in geometric transformations of images. So, if the result of the calculation of the coordinates (x_{im}, y_{im}) the obtained values, which do not go beyond the allowable range $([0, W_{im}), [0, H_{im}))$, that presence function $k_s(x_s, y_s)$ image at a given point of the screen is assigned the value of the presence function $k_{im}(x_{im}, y_{im})$, taken from the original image. Otherwise, $k_s(x_s, y_s) = 0$, that corresponds to the complete absence of information about the original image at a given point of the screen.

If necessary, mixing N images, the expression (8) is iteratively applied to each image:

$$E_{mi}(x, y) = (1 - k_i(x, y)) \cdot E_{i-1}(x, y) + k_i(x, y) \cdot E_i(x, y), \quad i = \overline{1, N}, \quad (9)$$

where $E_0(x, y)$ - the intensity of the particular color component of the background image of the screen.

Discussion: Currently, the drawing is firmly established in the practice of psychological diagnostics and has become one of the most common objects of psychological analysis [10-12].

Unlike other methods of psychological study of drawing has a number of advantages:

- a) can be used in the early stages of ontogenetic development, since 2-3 years;
- b) the use of drawing as a test takes considerably less time than many other tests, while its informational content can be much higher;
- c) drawing tests can be applied in a wide range of practical tasks: diagnostic, educational, correctional, as well as in various areas of psychology, from developmental psychology, psychology of creativity, to social psychology, legal psychology and psychology of labor;
- d) the drawing is providing for psychological analysis of large volume of both qualitative and quantitative indicators, that allows to test the degree of validity and reliability - are the most important requirements for psychodiagnostic methods.

When interpreting images, it is important to conduct a holistic (typological) and elementwise analysis to obtain informative and reliable results. Thus, the ready image is estimated from the position of availability of the content and plot, and analysed in terms of colors, relative size of figures and their relationship.

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