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Methodology of Correlation Analysis in Solution of a Problem of Normalization of Projective Image Transformations

Vyacheslav V. Lyashenko[1], Mohammad Ayaz Ahmad[2], Valentin A. Lyubchenko[3], Oleg A. Kobylin[4]

Abstract — Processing and interpretation of images is one of composing systems of the intellectual analysis of data. It is caused by that the significant part of information about outward things can be received on the basis of the video data analysis about images of the real world. At that, such analysis uses various methods, approaches and theories where the special place is occupied by the procedures connected with recognition of scenes or separate objects, presented on incoming images. Thus, it is necessary to consider the fact, that incoming images owing to objective factors could be subject to various geometrical distortions. Such distortions impose the restrictions and features on possibility of application of separate approaches and methods to processing and interpretation of images. Hence, a procedure of correlation normalization of images which allows to compare and recognize images is considered in this work. The work proves the possibility of representation of projective group of transformations, as one of versions of geometrical distortions of the incoming image, in the form of composition of the basic, simple transformations which are also versions of geometrical distortions of the incoming image. At the same time, the expediency of application of a partial correlation method for realization of procedure of correlation normalization of images is considered. The formalized description of the offered procedure of correlation normalization of images is given. Examples of separate steps of realization of the offered procedure are resulted.

Index Terms — image, normalization, recognition, correlation, geometrical distortions, projective transformation, computer vision.

1 Introduction

Consideration of possibility of application of various methods of analysis and image processing of the real world patterns which are presented in the form of digitized two-dimensional files of information plays the important role in the solution of concrete practical problems in the systems of intellectual analysis of data. It is connected with that the consideration of possibility of application of separate methods of analysis and image processing allows:

To choose the most comprehensible methods of analysis and image processing for considered system of intellectual analysis of data;

To optimize structure of considered system of intellectual analysis of data;

To increase a productivity and an overall performance of concrete system of intellectual analysis of data.

For example:

Wu pay attention to data clustering methods. It allows to realize various procedures of segmentation of images for their subsequent analysis and resulting of certain conceptual positions for acceptance of corresponding solutions on the basis of the analysis of incoming images [1];

Liu, Kobylin, prove an expediency of consideration and application of the wavelet analysis for construction of systems of intellectual analysis of data which operate with the images which displays the images of the real world [2], [3];

As methods of image processing for construction of systems of intellectual analysis of data Benz consider approaches of the theory of indistinct sets which allow to carry out not only the analysis of the received information in the form of images, but also draw corresponding conclusions in the conditions of available data about investigated object which is presented on the image [4];

As a image research method for the work of system of intellectual analysis of data Smith, Plaza suggest to consider topology of the presented data on the basis of studying of spatial statistics of separate elements of the image and their subsequent morphological analysis that allows to draw adequate conclusions at consideration of the interconnected sequence of the separate images which reflects some dynamic process [5], [6];

In systems of intellectual analysis of data which are based on image processing Buades choose methods of noise suppression which can be considered as one of initial steps to image processing [7].

Thus, various methods of processing and interpretation of images can be used at construction of systems of intellectual analysis of data which are based on the analysis of images. It is also necessary to consider, that as a rule, such images are derived by means of some system of computer vision which is capable to transform images of the real world into corresponding files of information [8], [9], [10]. At that, one of the primary goals in the systems of computer vision is a registration (compensation) of the distortions which occur both on a stage of image formation in the form of a picture of the real world, and

1. Laboratory "Transfer of Information Technologies in the risk reduction systems", Kharkov National University of RadioElectronics, 14 Lenina Str., Kharkov 61166, Ukraine. E-mail: lyashenko.vyacheslav@mail.ru
2. Physics Department, Faculty of Science, P.O. Box 741, University of Tabuk - 71491, Saudi Arabia. E-mail: mayaz.alig@gmail.com
3. Department of Informatics, Kharkov National University of RadioElectronics, Ukraine, 14 Lenina Str., Kharkov 61166, Ukraine. E-mail: lubchenko_v@mail.ru
4. Department of Informatics, Kharkov National University of RadioElectronics, Ukraine, 14 Lenina Str., Kharkov 61166, Ukraine. E-mail: oleg.kobylin@gmail.com

on a stage of transformation of the derived images, their subsequent processing, in particular, at recognition or tracking object. For example, incoming images can be subjected to such geometrical distortions as: compression, cross shift, turn, perspective and their combinations. Hence, one of the key methods of the analysis and processing of images in systems of intellectual analysis of data is an application of the geometrical analysis [11], in particular, for the solution of various problems of normalization of the derived images [12]. At the same time the normalization process, in particular the two-dimensional image, is a quite difficult procedure (in the computing plan) of visual image processing, in comparison with normalization of the image which is presented in the form of image on some straight line – so-called one-dimensional normalization [12]. Therefore application of one-dimensional normalization at consideration of a problem of two-dimensional normalization can be one of the ways of time reduction for process of image normalization. Such transition assumes applications of correlation procedures for comparison of investigated images for the purpose of their normalization. It, finally, defines a main objective of the given research, which consists in consideration of possibility of transition from two-dimensional normalization to one-dimensional normalization (or differently to search reduction of parameters of normalization) and possibility of application for the subsequent purposes of considered normalization of images of the correlation analysis methodology.

2 Normalization as an Object of Research in Image Processing

In the systems of computer vision as a component of systems of intellectual analysis of data, the image of the real world represents, as a rule, some three-dimensional object OO which does not change the absolute sizes in Euclidean space. Thus, the behavior of such object is described by affine model in space [13]. At obtaining of two-dimensional pictures of such object the set of the images connected among themselves by projective transformations is formed. If consider the geometrical distortions as a result of action of some group G, then set of the incoming images B which correspond to some standard B_0, consider as the class of equivalence W which is set by the standard $W(B_0) = \{B_1, B_2, ..., B_s\}$.

Then normalization procedure consists in automatic definition of unknown parameters of transformation which the incoming image is subjected, and its subsequent reduction to a reference form.

In the course of normalization the image is replaced with the equivalent. Transformations are carried out by means of normalization operators F which are called normalizers, and calculation of parameters of normalization is carried out with functionals Φ, operating on set of images. There are parallel, consecutive, parametrical and following normalizers. However, known normalizers work efficiency only for base transformations, such as displacement, turns, stretchings and cross shifts [13].

More difficult geometrical transformations demand additional researches for the purpose of application of the theory of normalization for image processing. Projective transformation is one of examples of difficult geometrical transformations that images can be subjected for. Generally projective transformations are described by projective group [13].

Complexity of operating with projective group is caused by the image under the influence of projective transformation changes not proportionally (unlike affine transformations), therefore the known methods of normalization which work well within the limits of affine model of perception, are unsuitable. Hereby, it is a necessity of consideration of an object in view of research.

3 Introduction Remarks and Substantive Provisions for Carrying Out of Researches

As the image we will understand a segmented picture B of investigated object OO in some field of vision Dz. The function from two variables $B(x, y)$ which designates a point (pixel) of image B with coordinates (x, y) is used for the mathematical description of the image. Value of this function defines intensity (brightness) in a point with various levels of gradation depending on a picture-size.

Interpretation (recognition) of the image is a comparison of the incoming image B (signs of the incoming image) with predetermined reference image B_0 (signs of the reference image). Dependence of incoming and reference images within the limits of projective model of vision are described by mathematical model [13]:

$$B(x', y') = B_0\left(\frac{b_{11}x + b_{12}y + b_{13}}{b_{31}x + b_{32}y + b_{33}}, \frac{b_{21}x + b_{22}y + b_{23}}{b_{31}x + b_{32}y + b_{33}}\right), \quad (1)$$

where the determinant of the matrix Π of considered transformation isn't equal to zero: $\det(\Pi) \neq 0$.

Thus, it is necessary to notice one classical and the most effectively working with the vision model method in the theory of image processing (1) it is a correlation. Image processing correlation method consists in a finding of a measure of affinity of the incoming and reference image.

Let some measure of proximity $\xi(B_0, B_k)$ is determined. Through $\overline{\xi}$ we will determine the value of the measure in an ideal case in this way: $\overline{\xi} = \xi(B_0, B_0)$. Then the correlation method of normalization will consist in a finding of such transformation $g \in G$ where value $\xi_g = \xi(B_0, gB_k)$ will be closest to true value $\overline{\xi}$. In practice, there is set a proximity threshold ε where some incoming image B_k (k –sets a number of the image from the multitude) is equivalent to the reference image B_0 if there is $g \in G$ wherein the condition is made $\left|\overline{\xi} - \xi_g\right| < \varepsilon$.

Correlation coefficients can be calculated by various ways, whereupon a minimum or a maximum coefficient will be chosen. A classical measure of convergence is a determination of a function maximum [13]:

$$\xi_g = \frac{\sum_{(x,y)\in Dz} B(x, y)B_0(x, y)}{\sqrt{\sum_{(x,y)\in Dz} B^2(x, y)}\sqrt{\sum_{(x,y)\in Dz} B_0^2(x, y)}} \to \max_{g\in G}, \quad (2)$$

where :

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Dz – field of vision,

$B(x, y), B_0(x, y)$ – incoming and reference images.

From (2) follows, that ξ_g works for 1 and ideally $\overline{\xi} = 1$.

On the basis of the found parameters $g \in G$ it is possible to construct some operator where a condition will be made:

$$F(B(x, y)) = gB(x, y) = B_0(x, y), \quad (3)$$

which is a normalizer concerning the group G action.

From normalizer determination (3) follows, that for any images $B_1, B_2 \in W$ $F(B_1) = F(B_2)$ is fair, and it gives a chance to construct a normalizer without determination of some reference image.

Thus, a normalizer construction defines a task of imaging construction $\Phi: W \to G$, where for every $B_k \in W$ we find an element $g_k \in G$, that $F(B) = gB$.

Then imaging Φ should satisfy a condition: $\Phi(gB) = \Phi(B)g^{-1}$.

Also it is necessary to consider, that for the group G and multitude of incoming images W the uniqueness condition is made:

If, $g_e B = B$

then $g_e = e$ is a group unit.

Then there is an equation $(\Phi(B))^{-1}\Phi(gB)g = e$ where the group unit G is a transformation $\Phi(B_0)$, therefore $\Phi(B) = g^{-1}$ provides determination of unknown parameters of transformation of group G by imaging construction: $\Phi: W \to G$ [13].

It is possible to assert, that the correlation method of normalization of the image is the most reliable, but the most laborious method because it supposes an exhaustive search of signals in space. Laboriousness of the correlation method directly depends on quantity of parameters of group G. The increase of this quantity leads to such considerable calculations, that sometimes direct application of correlation algorithms is impossible in real mode of time. It has caused a creation of modifications of correlation methods which would provide same reliability at laboriousness reduction. Among such modifications are the methods of private correlations. Their basic idea consists in that incoming and reference images are divided into sites. The correlation coefficients are calculated for every site. All these correlation coefficients are made in one general correlation coefficient by a certain rule. However within the limits of multiparameter group of transformations, the way of image partition on sites still remains. Thus, it is possible to consider the solution of the given problem as one of the first stages of disclosing of an object in view of research.

4 Projective Group of Transformations as a Composition of Set of Basic Transformations

It is possible to show, that:

$$\Pi = D_{nm}P_yP_xH_xUC_{xy}, \quad (4)$$

where:

D_{nm} – compression along axes,

P_y – prospect transformations along ordinate axis with parameter t,

P_x – prospect transformations along abscissa with parameter k,

H_x – cross shift along abscissa on the corner β,

U – turn on the corner α,

C_{xy} – deflection.

For this purpose it is necessary to notice, that the projective group supposes expansion [13]:

$$\Pi = \Pi_ц C_{xy}, \quad (5)$$

where:

$\Pi_ц$ – centroprojective group.

Thus action of centroprojective group with the reference image is connected by a ratio:

$$x' = \frac{b_{11}x + b_{12}y}{b_{31}x + b_{32}y + 1}, \; y' = \frac{b_{21}x + b_{22}y}{b_{31}x + b_{32}y + 1}, \quad (6)$$

At the same time set of transformations of type (6) forms group concerning multiplication operation, and any element of this group we will present as:

$$\Pi_ц = D_{nm}P_y(t)P_x(k)H_x(\beta)U(\alpha), \quad (7)$$

where

$$D_{nm} = \begin{pmatrix} m & 0 & 0 \\ 0 & n & 0 \\ 0 & 0 & 1 \end{pmatrix}, \; P_y(t) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & t & 1 \end{pmatrix},$$

$$P_x(k) = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ k & 0 & 1 \end{pmatrix}, \; H_x(\beta) = \begin{pmatrix} 1 & tg(\beta) & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix},$$

$$U(\alpha) = \begin{pmatrix} \cos(\alpha) & \sin(\alpha) & 0 \\ -\sin(\alpha) & \cos(\alpha) & 0 \\ 0 & 0 & 1 \end{pmatrix}.$$

Let's show, that transformation of type (6) is a group.

For this purpose we will check up all attributes of the group.

Associativity, existence of the inverse element and the unit follows directly from properties of matrixes and transformation existence.

Thus the composition of two transformations of type (6) is a transformation of the same kind.

$$\begin{pmatrix} c_{11} & c_{12} & 0 \\ c_{21} & c_{22} & 0 \\ c_{31} & c_{32} & 1 \end{pmatrix} x \begin{pmatrix} b_{11} & b_{12} & 0 \\ b_{21} & b_{22} & 0 \\ b_{31} & b_{32} & 1 \end{pmatrix} = \begin{pmatrix} c_{11}b_{11} + c_{11}b_{21} & c_{11}b_{12} + c_{12}b_{22} & 0 \\ a_{21}b_{11} + a_{22}b_{21} & a_{21}b_{12} + a_{22}b_{22} & 0 \\ a_{31}b_{11} + a_{32}b_{21} + b_{31} & a_{31}b_{12} + a_{32}b_{22} + b_{32} & 1 \end{pmatrix}$$

Then competency of expansion (7) directly follows from the system:

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$$\begin{cases} b_{11} = m(\cos(\alpha) - tg(\beta)\sin(\alpha)); \\ b_{12} = m(\sin(\alpha) - tg(\beta)\cos(\alpha)); \\ b_{21} = -n\sin(\alpha); \\ b_{22} = n\cos(\alpha); \\ b_{31} = t(\cos(\alpha) - tg(\beta)\sin(\alpha)) - k\sin(\alpha); \\ b_{32} = t(\sin(\alpha) + tg(\beta)\cos(\alpha)) + k\cos(\alpha). \end{cases}$$

and inverse system:

$$\begin{cases} n = \pm\sqrt{b_{22}^2 + b_{21}^2}; \\ \alpha = \begin{cases} -\operatorname{arctg}\left(\dfrac{b_{21}}{b_{22}}\right), \text{at } b_{22} \neq 0; \\ 90, \text{at } b_{22} = 0; \end{cases} \\ \beta = \begin{cases} \operatorname{arctg}\left(\dfrac{b_{22}\cos(\alpha) - b_{11}\sin(\alpha)}{b_{11}\cos(\alpha) + b_{22}\sin(\alpha)}\right), \\ \text{at } b_{11}\cos(\alpha) + b_{22}\sin(\alpha) \neq 0; \\ 90, \\ \text{at } b_{11}\cos(\alpha) + b_{22}\sin(\alpha) = 0; \end{cases} \\ m = \begin{cases} \dfrac{b_{11}}{(\cos(\alpha) - tg(\beta)\sin(\alpha))}, \ (\cos(\alpha) - tg(\beta)\sin(\alpha)) \neq 0; \\ \dfrac{b_{12}}{(\sin(\alpha) + tg(\beta)\cos(\alpha))}, \ \text{in other cases;} \end{cases} \\ t = b_{32}\sin(\alpha) + b_{31}\cos(\alpha); \\ k = \begin{cases} \dfrac{t(\cos(\alpha) - tg(\beta)\sin(\alpha)) - b_{31}}{\sin(\alpha)}, \ \text{at } \sin(\alpha) \neq 0; \\ \dfrac{b_{32} - t(\sin(\alpha) - tg(\beta)\cos(\alpha))}{\cos(\alpha)}, \text{in other cases} \end{cases} \end{cases}$$

Let's notice, that in last system $(\cos(\alpha) - tg(\beta)\sin(\alpha))$ and $(\sin(\alpha) + tg(\beta)\cos(\alpha))$, and $\sin(\alpha)$ simultaneously $\cos(\alpha)$ don't become a zero, otherwise $b_{11} = b_{12} = 0$ and $b_{21} = b_{22} = 0$ accordingly, that conflicts with a condition of existence of transformation $\Pi_ц : \det(B) \neq 0$.

Thus, all conditions of existence of expansion (7) are made. Hence, there is also expansion (4).

5 Expansion of Projective Group of Transformations in Realization of Coorelation Normalization Procedure for Image Processing

On the basis of expansion (4) it is possible to construct a consecutive normalizer of projective group in a following kind:

$$F_{\Pi} = F_{Dnm}F_{Py}F_{Px}F_{Hx}F_{U}F_{Cxy}, \quad (8)$$

where:

F_{Π} – normalizer of centroprojective group,

F_{Cxy} – normalizer of deflections;

F_U – normalizer of group of turns;

F_{Py}, F_{Px} – normalizers of group of prospect along ordinates axes and abscisses accordingly;

F_{Hx} – normalizer of group of cross shift along abscisses,

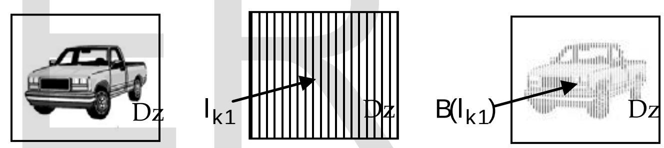
F_{Dnm} – normalizer of group of compression.

For the use of normalizer (8) and the method of partial correlations for the purpose of image processing we will insert some additional determinations and carry out a number of constructions.

Determination. Restriction $B(l_{k1})$ image B on a straight line is their general part: $B(l_{k1}) = B \cap l_{k1}$, in other words, the part of the image which coincides with a straight line arrangement l_{k1}.

Let the $\{l_{k1}\}$ family consists from $s1$ ($k1 = \overline{1, s1}$) straight lines which are equidistant from each other and parallel to ordinates axis and they are in the field of vision Dz.

Then restrictions on straight lines $B(l_{k1})$ are formed from those sites of the image B which are crossed with the straight lines of considered a family (as shown in Fig. 1).



(a) (b) (c)

Fig. 1. Transition from the image to its restrictions on the family of straight lines $\{l_{k1}\}$ which are parallel to ordinates axis: a) – initial image B; b) – family of straight lines $\{l_{k1}\}$; c) – restrictions $B(l_{k1})$ of the image B on the family of straight lines $\{l_{k1}\}$.

It is similarly possible to derive restrictions on horizontal straight lines. In essence, digitization is the restrictions on vertical or horizontal straight lines with a quite little step. However, the use of horizontal and vertical straight lines at difficult transformations is often limited by possibilities.

Then the analysis of the straight lines which pass through the set point is more universal. We will set some reference point and consider a set of the straight lines $\{l_{k1}\}$ which pass through it, with an identical corner between l_{k1} and l_{k1+1}.

Let the reference and deformed images of a set as shown in Fig. 2 (a-b).

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Fig. 2. Test images: (a) – reference image and (b) – incoming image.

In a random way we'll choose a point M on the standard. Then we'll pass from the image to its restrictions on the straight lines which pass through a point M (Fig. 3.a). Then we'll present the derived families of straight lines in the form of the matrix (Fig. 3.b).

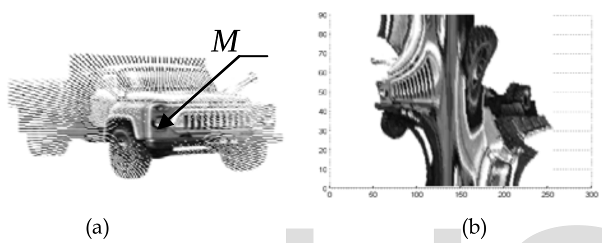

Fig. 3. Representation of the standard in the form of restrictions on 180 straight lines: (a) – restrictions on the straight lines and (b) – visualization of the matrix of restrictions.

The incoming image has been derived by influence on reference with projective transformation (Fig. 4a).

Now let's construct set of restrictions on the straight lines $\{N_j\}$ which pass through a point N, on the basis of the deformed image has been shown in Fig. 4b.

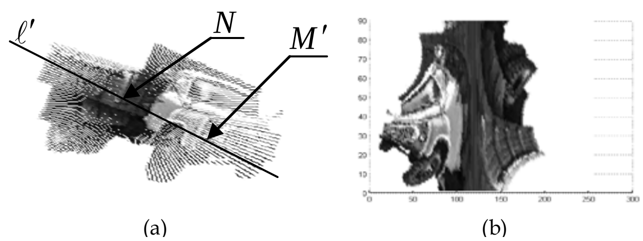

Fig. 4. Representation of the incoming image in the form of restrictions on 180 straight lines: (a) – restrictions on straight lines and (b) – matrix of restrictions.

From classical projective geometry it is known, that a straight line passes into a straight line [14], hence, the straight line l will pass into the straight line l'. As the straight line l has the point M, and the straight line l' – the point N, it is possible to draw a conclusion that there is some straight line M_i from the multitude $\{M_i\}$ which corresponds to the straight line l, and there is some straight line N_j from the multitude $\{N_j\}$ which corresponds to the straight line l'. And since the straight line l' is the image of the straight line l, then the straight line N_j is the image of the straight line M_i.

The straight lines are connected by one-dimensional projective group of transformations:

$\Pi_0 : x' = \dfrac{mx}{tx+1}$, which matrix can be presented in the form of expansion:

$$\Pi_0 = \begin{pmatrix} m & 0 \\ t & 1 \end{pmatrix} = \begin{pmatrix} m & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ t & 1 \end{pmatrix} = D_0 P_0,$$

where D_0 – one-dimensional compression, P_0 – prospect transformation.

Thus, one of ways of normalization of a projective straight line is a correlation procedure with 2 parameters: means of compression. By means of compression and perspective it is possible to find in multitude $\{M_i\}$ and $\{N_j\}$ corresponding l and l' with some parameters of one-dimensional compression and perspective which connects these straight lines.

In Fig. 5 examples of the determined straight lines l and l' are resulted.

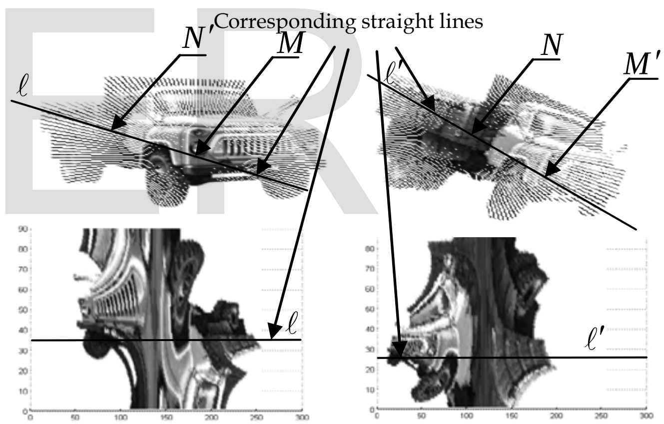

Fig. 5. The image of the straight line of the reference image in projectively deformed image.

On the next stage on the reference and incoming images we will randomly choose other, distinct from M and N, points D and K accordingly concerning which we will receive restrictions on the straight lines. This has been shown in Fig. 6.

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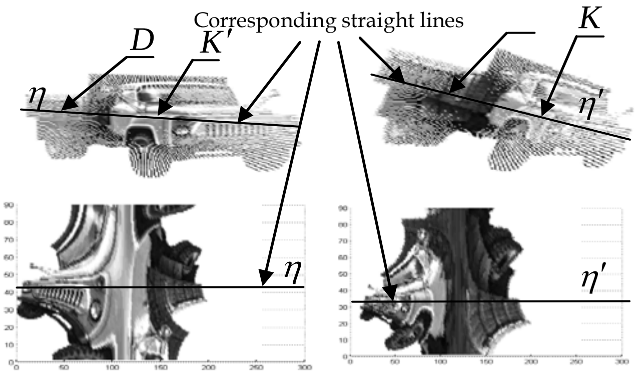


Fig. 6. The image of the straight line of the reference image in projectively deformed image through the points D and K.

Thus, we find the straight line η' of the incoming image which is the image of the straight line η of the standard. As a result we derive two straight lines l and η which images l' and η' are known. Let the straight lines l and η are crossed in the point O then the point O' which is located on the straight lines crossing l' and η', is its image. Using coordinates O and O' it is possible to determine the parameters of normalizer F_{Cxy} which will execute a centering of two images.

Let's arrange the beginning of coordinates of reference and incoming images accordingly in points O and O' (Fig. 7).

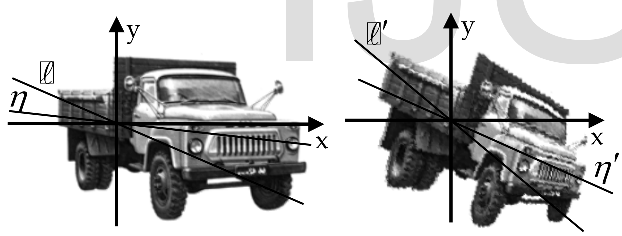


Fig. 7. Images with corresponding straight lines: (a) – reference image and (b) – incoming image.

Further, the straight lines, derived on incoming and reference images, are transferred on one axis for convenience (Fig. 8).

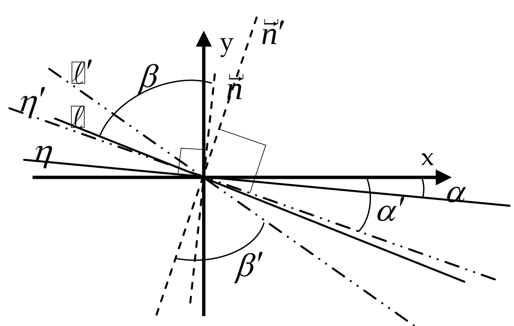
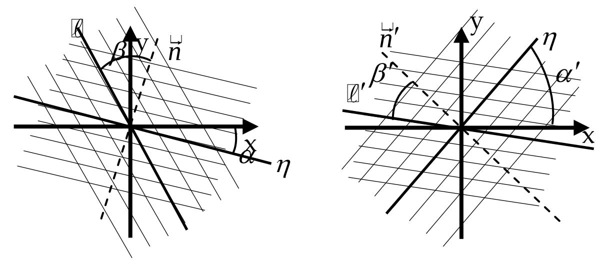


Fig. 8. Geometrical representation of the derived straight lines.

In Fig. 9 α – corner between η and OX axis; α' – corner between η' and OX axis; β – corner between l and $\vec{n}$; $\vec{n}$ – vector of normal to the straight line η; β' – corner between l' and $\vec{n}'$, where $\vec{n}'$ – vector of normal to the straight line η'; m, t – parameters of compression and prospective along the vector l': m – compression, t – prospective; n, k – parameters of compression and prospective along the vector η'.



(a) (b)

Fig. 9. Graphic representation of the image: (a) – reference image and (b) – incoming image.

We will consider the image normalization (Fig. 2.) on the derived parameters of transformation on the example (Fig. 9, Fig 10) where the normalized grids of the image (Fig. 10) are imposed on the found straight lines of the reference and entrance image.

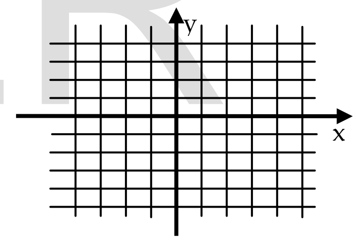


Fig. 10. The normalised grid of the image.

Then it is necessary to carry out transition from reference and incoming images (Fig. 9) to some new images that the mapped grid has become (Fig. 10). For this purpose we will use a consecutive normalizer (8): we influence on reference and incoming images by normalizers of turn $F_{U(\alpha)}$, $F_{U(\alpha')}$ and cross shift $F_{Hx(\beta)}$, $F_{Hx(\beta')}$.

In other words, we will turn reference and incoming images in such a way that direct images η and η' coincided with abscissa. We influence with transformation of cross shift on corner β and β' in such a way that there was a corner of 90 degrees between η, l straight lines and η', l' straight lines.

Then we are going to result the incoming image, which was derived on the previous step, to the modified reference image. We will use prospective normalizers along abscissa $F_{Px(tg(\beta)*t)}$ and ordinates of axis $F_{Py(tg(\beta')*k)}$. The derived pair is differed only by transformation of compression which is compensated

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by normalizer F_{Dmn}. As a result we will derive the normalized images.

In the formalized form the procedure of normalization of the image by means of methodology of the correlation analysis looks as:

1. We pass from reference and incoming images to their restrictions on straight lines $\{M_i\}$ and $\{N_j\}$ accordingly $i = \overline{1, r_1}$, $j = \overline{1, r_2}$, where r_1 and r_2 – a quantity of considered straight lines for realization of correlation procedure of normalization.

2. Every straight line from the multitude $\{M_i\}$ is correlatly compared with the straight lines from the multitude $\{N_j\}$. We record the derived coefficients of correlation τ_γ for every pair of straight lines $\{M_i\}$ and $\{N_j\}$, $\gamma = \overline{1, r_1 \cdot r_2}$.

3. We find the maximum (minimum) coefficient of correlation $\tau_{max(min)}$. Let it reaches a minimum for straight lines $M_i = l$ and $N_j = l'$.

4. We centre images: we are going to move and turn reference and incoming images in such way, that direct images l and l' will coincide with abscissa, and the point of the incoming image, which lies in the centre of coordinates XOY, will be an image of a point of the reference image, which lies in the centre of coordinates $X'O'Y'$ (it's easy to do because the parameters of conformity for the straight lines l and l' are known).

5. We pass from the centered incoming image to restrictions on straight lines $\{O_j'\}$, which pass through the beginning of coordinates O', $j = \overline{1, r_2}$.

6. For the straight line η of the reference image which coincides in a direction with ordinates of axis, we find its image η' in the multitude $\{O_j'\}$. Let thus compression and prospective coefficients are equal to n and k accordingly. Let the vector $\bar{n}$ is perpendicular to the straight line η'. Then we will mark the corner β between straight lines $\bar{n}$ and η'.

7. We normalize the incoming image by means of normalizer (8).

6 Conclusions

Thus, the general procedure of correlation normalization of images which is presented in the form of the separate formalized stages on its realization is considered in this work. At that consideration is based on a careful substantiation of key positions of the offered procedure. In particular among the key positions of the offered procedure it is necessary to notice:

Substantiation of possibility of representation of projective group of transformations, as one of versions of geometrical distortions of the incoming image, in a kind a composition of set of the basic, more simple, transformations which are also represented by separate versions of geometrical distortions of the incoming image;

Expediency of application of the partial correlation method for realization of procedure of correlation normalization of images.

At the same time it is necessary to notice, that transition from two-dimensional images to their restrictions on the straight lines allows to pass from a challenge of determination of nine parameters of projective group to one-dimensional projective group with two parameters.

The considered procedure of correlation normalization of images allows to build adequate normalizers by using one-dimensional normalization, expansion of centroprojective group and methodology of partial correlation. Finally, it gives the opportunity to carry out normalization for two-dimensional images in comprehensible timetable and to develop the unified devices for normalization of images.

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