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Recognition of fragments of standard images at low light level and the presence of additive impulsive noise

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***Abstract* – On the basis of integral disproportion function of the first-order the algorithm recognizing fragments of standards is created. It works in low light image that is analyzed and the presence of additive impulse noise. This algorithm permits to fin an appropriate pixel in one of several standards for each pixel of the image.**

***Keywords:* disproportion function, fragments of standards, image recognition, low lighting, additive impulse noise, bipolar impulse noise .**

I.INTRODUCTION

The recognition of the fragments of standard photo and video images on the image, that is analyzed, often is occur in practice. For example, some standard objects or the parts of them may be present on the terrain. Some objects may be imposed on other one or to be closer to each other. In addition, they may be different scale images or to be shifted and rotated compared to the standards. Besides of they may be distorted due to geometric transformations. For digital camera a camcorder the images are represented as two-dimensional arrays of pixels. Each pixel has its own color value. These are transparency and intensity of red, green and blue components. Each of them can vary from 0 to 255. There are many papers devoted problem of image recognition. In particular, a very effective tool is to normalize distorted images [1]. Pattern recognition based on fuzzy neural classifier provided the facility that is recognized correctly positioned relative coordinate axes, is proposed in [2].

However, the problem of recognizing fragments of standards in low light image that must be analysed, is actual. Basically, it is recommended to use a more sensitive equipment or devices that operate in the infrared spectrum. However, even in the daytime lighting levels can deteriorate rapidly. In addition, obtaining video images may occur when there are the smoke, the fog, or the sediments. All this leads to a weakening of the intensities of the components that determine the color of the pixel in the digital image. It is possible that may arise the conditions under which these components will be reduced differently. Compared to the brightness of red, green and blue components of the standards, these components of the images that are analyzed, will be less. The attenuation may be equal for all components, in case there is reducing lighting, and it is different, if the image is fixed through a medium which absorbs differently frequencies of the visible spectrum.

In any case, the problem is not so much in getting the intensities of brightness components of pixels. It's necessary to recognize the fragment of standard to which every pixel of image corresponds. In fact, there is a need for recognition in a conditions, where each component color image pixel intensity is proportional to the intensity of the standard, but the factor of proportionality is unknown. Its value can't be determined simply by dividing the intensities for pixels that are randomly taken from image and from standard one. It can be explained because it isn't known the standard for which the pixel selected from image corresponds. Thus, even in circumstances where an image that is analyzed, has the same size, isn't shifted and isn't returned relatively standard one, it isn't simply to identify the fragment of this standard.

In fact, it's necessary to check the proportional relation between the color of every pixel of image and the pixel color for each of standards.

Another problem is solving the above problem in the worse conditions, when there is reducing lighting and a noise is superimposed on a video signal.

Getting and video signal transmission usually occurs in the presence additive noise as well as multiplicative one. Often there is an additive bipolar impulse noise.

This signal has a peculiarity. It has the impulses often are more than video signal amplitude. In this case the pixels, which got the pulses of noise become either white or black [3].

The cause of bipolar pulse noise may be a result of electric welding, electrical discharges, switching processes in electrical circuits etc. Thus, we must first recognize a moment when the noise disappeared and to recognize the fragment of standard before the noise will arise again.

Often the impulse noise appears and disappears at random time. That is, the noise is a random process. In practice, the statistical characteristics of this process are unknown. This doesn't allow to implement it's effective filtering.

In principle, recognizing a fragment of standard image can be in those intervals when the noise disappears, but these intervals must also be recognized. The solving of this problem is complicated because according conditions it's unknown which pixel of image corresponds to which pixel of standard at current time.

Moreover, this standard is unknown also. In [4] this problem is considered for the case where the obstacle is described by smooth function. However, the impulse noise mostly often is not smooth.From the outset let's consider solving the problem when there is no noise.

II. FORMULATION OF THE PROBLEM IF A NOISE IS ABSENT

There are m reference images (standards), represented by matrices of pixels.

After scan there are the arrays of red $R_k[q]$, green $G_k[q]$ and blue $B_k[q]$ brightnesses for every pixel and for every standard, where k = 1,2, ... m - the order number of the standard;q = i * w + j - the order pixel number;w - the number of pixels in one line;j - the order pixel number in a row;i - line number $0 \leqslant i \leqslant h$; h - the number of rows.

Also there are the arrays of brightness's r[q], g[q] and b[q] respectively red, green and blue components of the color pixels of image, that must be analyzed. It is obtained in low light. This image consists of fragments of standards that must be recognized. In the case where a pixel in the image corresponds to the pixel k- th standard, their brightness are proportional:

$r[q]=k_r R_k[q];$ (1)

$g[q]=k_g G_k[q];$ (2)

$b[q]=k_b B_k[q],$ (3)

where k_r, k_g, k_b - the coefficients attenuation brightness's.

In general, these factors may be different depending on the medium through which light passes. In addition, they might accidentally change over time, for example, by passing clouds or of smoke. Thus, to solve problem it's necessary to find for every pixel of image the appropriate pixel of standard. In this case will be a proportional relation between brightness's of these pixels at least for one component. But it must be executed in case, when the coefficients of attenuations for brightness's are unknown and their values are random. So it's necessary to use the method is invariant to the coefficient of proportionality.

III. SOLVING THE PROBLEM IF THE NOISE IS ABSENT

The disproportion function by derivative of first range for numeric functions, that are defined as parametric , corresponds for all conditions, that were showed above [5].

This disproportion function of y (t) with respect to x(t) is described by the expression:

$$z(t) = @d^{(1)}_{x(t)}\, y(t) = \frac{y(t)}{x(t)} - \frac{dy/dt}{dx/dt}, \quad (4)$$

where @ - character that defines the computing disproportion;

d - means derivative.

There is an order of disproportion in round brackets.

Reading: «at d one of y (t) with respect to x (t)».

In case if

$$y(t)=kx(t), \quad (5)$$

where k - constant factor,

disproportion (4) is equal to zero regardless of the value of the coefficient k in (5).

Note that the brightnesses (1), (2), (3), as well as the brightnesses of standards are discrete.

That's why an integral disproportion function of first order [6] is proposed instead of disproportion (4) .

The integrtal disproportion function of r[q] with respect to $R_k[q]$ has the form:

$$I[q]=@I^{(1)}_{R_k[q]}\, r[q] = \frac{r[q-1]+r[q+1]}{R_k[q-1]+R_k[q+1]} - \frac{r[q]}{R_k[q]} \quad (6)$$

It is proposed calculate the disproportion (6) for the color components of each image pixel with respect to color components of each pixel for all standards. Further driven algorithm for solving the problem for example when analyzed red brightness .

1 Read brightness $R_k[q]$ of red component for pixels of standards: (k = 1,2, ... m), (q = 1,2, ... hw);

2 Read brightness r[q] of red component for image pixels: q=1,2,…hw;

3 Set the standard k=1;

4 Calculate disproportion (6) of r [q] with respect to R_k [q] and to store their values (q = 1,2, ... hw);

5 k = k + 1;

6 If k <= m, go to p 4. Otherwise – go to p 7;

7 Show the results for each standard.

This can be done in different ways. You can simply print the values of disproportions and can reproduce images on the screen, which will display the pixels of the standards for which disproportion (6) is zero. It is not excluded that some standards may have identical fragments. The algorithm tested on test case in the processing of all 3 components. As standards two photos (Fig.1) are used.

Figure 1. The standards

One of them are the trees over a river. Another – a cat is sleeping on the computer table. Further the image for recognition is showed (Fig.2). The part of this image is a fragment of computer table and further is a part of a cat. The next part is a foto of trees. Due to a low level of lighting this image is almost black. In these cases, it's difficult to recognize these fragments. So the algorithm that is proposed was used. As a result, the disproportions (6) have received zero values for the corresponding pixels of corresponding standards. On Fig.2 there is an image for showing the results. It was built with using disproportion values. On this image the fragments of both etalons are recognized. So the test passed successfully.

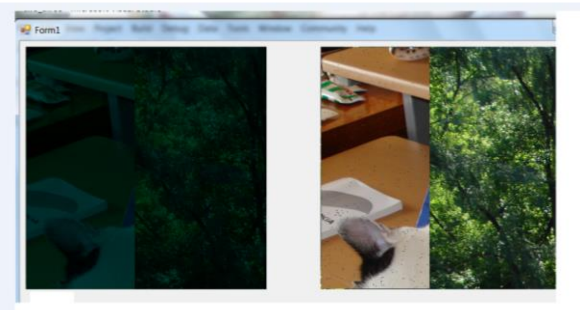

Figure 2 – Image for recognition (black), image of results

IV. Recognition at low-light images and with presence of impulse additive noise

Let's consider this problem, for example, for red component r [q] color of q - th pixel image, that is analyzed,only.

When the brightness's of q-th image pixel are fixed, the noise η (t) is added. Thus, the noise impact is tied with pixel. The noise may be represented by η[q], q = 1,2, ... wh.

So in the presence of additive noise the brightness signal of red component has the form:

$$y[q]=r[q] + \eta[q], \quad (7)$$

The next expression was received after substituting expression (1) to (7) :

$$y[q]=k_r R_k[q] + \eta[q], \quad (8)$$

Under conditions of the problem k_r - is unknown.

The standard k, which corresponds to a pixel of image, is unknown also.

As in the previous case, for each k = 1,2, ... m the disproportion (4) of the signal y(t) (8) with respect to $R_k[q]$ is calculated.

$$z_k[q]= \frac{k_r R_k[q] + \eta[q]}{R_k[q]} - \frac{k_r R'_k[q] + \eta'[q]}{R'_k[q]} = @d^{(1)}_{R_k[q]}\ \eta[q]. \quad (9)$$

At a time when the noise disappears the value of disproportion (9) is equal to zero. Thus, if zk[q] = 0, it means no noise and the fact that the image pixel corresponds to the pixel of k - th standard.If for all standards $z_k[q] \neq 0$, it may indicate the presence of noise. Also may be a case where a pixel image does not correspond to any standard.However, the disproportion (9) can be calculated only when the noise is smooth and has a first derivative. In general, the impulsive noise can't be differentiate. Also, again, we must remember that the brightnesses are discrete. Therefore, in this case, the integral disproportion of first-order of signal y[q] with respect to R_k [q] is proposed also:

$$I[q]=@I^{(1)}_{R_k[q]} y[q] = \frac{y[q-1]+y[q+1]}{R_k[q-1]+R_k[q+1]} - \frac{y[q]}{R_k[q]} \quad (10)$$

Thus, in the case of additive impulsive noise the integral disproportion (10) should be calculated and it must be compared with zero, as was done with the disproportion (9). So, with the presence of additive noise the algorithm given above is used. But now there is recognition only in the intervals when there is no noise.Obviously, the algorithm requires significant computing resources, but at the same time, it allows parallelization of computing. For example, you can simultaneously work with multiple standards.It should also be borne in mind that the implementation of the algorithm allows only get information for decision-making system. This system relates the fragment of an image with a standard.

V. Conclusions

The algorithm for analyzing of image to recognize on it some fragments of standards is proposed. The lighting of image may be low. In addition, the impulsive noise may be added to the video signal of image. For this purpose the integral disproportion function of first order of brightnesses color components of each pixel image with respect to brightnesses of each pixel standard is used. The algorithm can be used in the system of decision making at analyzing photos and video images.

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