Methodology of Two-Stage Masking Images in Information and Telecommunications Systems

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Abstract – **The questions of comparative evaluation of the most common methods of concealment. Demonstrates the use of previously-based measures quantify the quality of the detection and localization of the contours to compare methods. The results of the experiment on the use of masking. The need to apply the cascade methodology masking problems in image processing.**

I. Introduction

In various application areas related to image processing, it is necessary to consider into account the semantic component of the image. The most semantically meaningful information about the contours, the edges of objects. One of the basic components of semantic processing is the concealment techniques. These technologies allow you to highlight informative details about the structural characteristics of objects in images. By masking the image we mean methods (algorithms, methods) discovery (search and localization) contours (boundaries of circuits) in the images by moving the mask (filter).

II. Statement of the problem

Detection contours there is a great variety of techniques and mask images. One effective approach for constructing concealment methods are methods based on building gradient [1-3, 6-8]. Gradient (differential) methods based on the detection at each point of the approximate values of the brightness gradient and direction of their greatest change, which serves to emphasize the position change of brightness. These methods are integrated methods for the edge detection, the direction of which is arbitrary.

There are no universal methods of concealment for different types of images [1, 6]. This leads to the fact that the existing methods are only effective within a narrow class of images. Therefore, the lack of reliable methods for evaluation of the device masking results in the restriction to increase their effectiveness. In most cases, the evaluation of quality masking method is limited only by subjective assessment (visual assessment of the work quality). But this approach is only applicable in cases where the processing systems - the decision-maker. Thus, the task of quantifying the quality concealment methods in realistic image processing systems is the actual scientific - applied problem.

One solution to the problem is to construct a two-stage scheme of concealment. This will reduce the disadvantages of mutual concealment methods used in the first and second stages of the phased evaluation implementation of the concealment quality. Therefore, the purpose of research paper is to justify the approach to masking images based on two-stage technique using a quantitative assessment of the concealment methods quality for the formation of transformation operators in cascade on processing.

III Quality assessment method for the two-stage masking images technology

Assessment of the work quality, study methods perform on the test images. As test images using GT-imagery, ground truth images - images that contain a common understanding of the researcher border with database of California Berkeley University, Computer Vision Group [4], and computer graphics laboratory of Moscow State University [5].

Key measurement concealment methods considered in the paper [1 - 3, 6 - 8]. In these studies suggest methods of theoretical and empirical evaluation of the detection and localization quality of the contours. Score concealment methods is carried out based on the following measures quality detection and localization of [1, 6 - 8]:

1) an error of first kind α - the ratio of incorrectly selected boundary pixels to total number of the pixels which are not boundary or its derivative - specificity S_p, as the ratio selected not boundary pixels to total number not boundary pixels of a GT-image;

2) an error of second kind β - the ratio of not selected boundary pixels to total number of boundary pixels or its derivative sensitivity S_e - the ratio of correctly selected boundary pixels to total number of boundary pixels of a GT-image;

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3) an amount of correct certain pixels in comparison with an ideal contour – N corr.;

4) an amount of wrong certain pixels in comparison with an ideal contour - N incorr.;

5) mean squared error RMSE (Root Mean Square Error), defined as distance between two pixels of compared images [2, 3, 13];

6) the spades ratio of a signal/noise - PSNR.

As additional parameter it is offered to spend an estimation of handling time of the image – t (ms), the handling consisting of the method an operating time, time of measures calculation of qualities and a conclusion of processing outcomes. The metrics (1) - (4) allow spending an estimation of detecting quality of contours, metrics (5) and (6) estimation of quality of contours localization. The given metrics also allow to estimate the basic errors and distortions (ruptures, local displacement, spreading and thickenings of contours), brought by masking methods in the treated image [1 - 3].

Let's hold testing of the masking applied in systems methods of images automatic handling. Testing is understood as visualization of handling outcomes and a quantitative estimation of method quality masking (an evaluation of the offered metrics (1) - (7)). Were considered for testing the most widespread methods using a gradient of the image - operators of Prewitt, Sobel, Sharu, Laplace (2 aspects), Laplasian, a method of Hrjashchev and a mask of a method Canny (factors calculate for a mean squared deviation σ = 1, 4) [1 - 3]. Matrixes of transformation for masking methods are known [1 - 6]. At an estimation of work quality of masking methods as the entering have been used: realistic images (color and half-tone) identical sizes and GT-images for the given realistic images.

In the calculation of metrics to compare images - the result of the masking method and a binary image of GT. When comparing the methods of concealment used in the proposed objective quality metrics (1) - (6), which, for all its shortcomings compared with subjective quality assessment (based on an assessment of the visual quality of the image processing) can be used in automatic image processing.

IV. Result of testing

In the article the estimation of quality of masking methods (the entering image, outcome of handling, rated values of metrics) for the image "37073" of base [4, 5] is presented: color and half - tone realistic image with a natural background, a size - 481x321 pixels, a solution 300x300 dpi, depth of color 24 bit both 8 bit and corresponding to them GT - an image (fig. 1 a) and b)). For the realistic image "37073" outcome of handling is presented in drawing 1, in table 1 the calculated values of quality indicators of masking methods (the bold type selects corresponding minimum and maximum values of metrics) are presented. During researches were the analysis more than 300 realistic images from databases [4, 5] is carried out.

As a result of the spent researches of widespread methods of masking it is possible to draw following conclusions:

a) the analysis of metrics shows insignificance values of images chromaticity for masking methods (the tendency in work of methods "better - worse" remains, values of quality indicators - no more than 5 - 8 % slightly vary);

b) the best indicators of quality of contours search at a method of Sobel (N cor. = 150723, N incorr. = 2078, RMSE = 0,116616411531842, PSNR = 18,6648065325059 (values table 1);

c) the best indicators of quality from the point of view not to add false contours at a method of Hrjashchev (value of an error of first kind α = ,89383251944294E-5 and specificity S_p = 0,999971061674806) with simultaneously worst values of performances of the real admission contours and origins of ruptures (an error of second kind β = 0,955063117453348 and sensitivity S_e = 0,044936882546652);

d) the best indicators of quality from the point of view do not miss real contours and origin of boundaries ruptures at a method Sharu (errors of second kind β = 0,001 and sensitivity S_e = 0,999);

e) the best indicators of quality from the point of view unadmission real contours and origin of boundaries ruptures at a method to the Sharu (errors of second kind β = 0,001 and sensitivity S_e = 0,999).

The quantitative estimates are confirmed by the visualization of the processing realistic images results

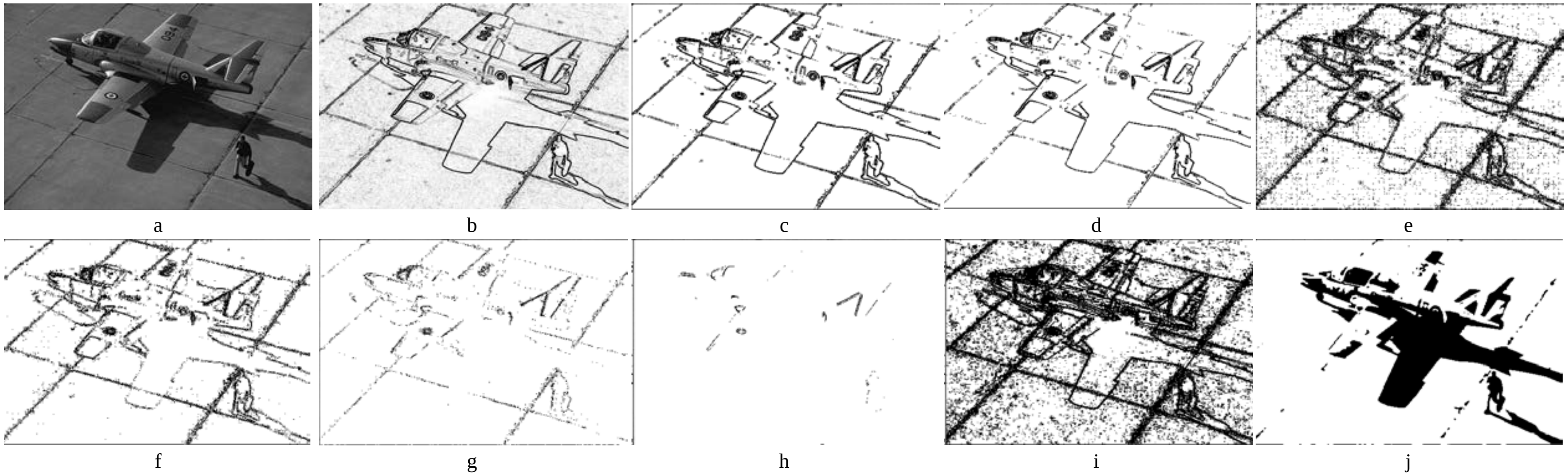

Fig. 1. Visual representation of image processing by methods of masking (half-tone image "37073"): a – the initial half-tone image; b – GT-image; c – result of processing by a method of Sobel; d – a method of Prewit; e – a method of Sharu; f – a method of Laplace 1; g – a method of Laplace 2; h – a method of Hrjashchev; i – a method of Laplasian; j – a matrix on method Canny

TABLE I THE CALCULATED VALUES OF QUALITY INDICATORS OF MASKING METHODS

Parameters	Methods of masking							
	Sobel	Prewit	Sharu	Laplace 1	Laplace 2	Hrjashchev	Laplasian	matrix Canny
	"37073", the half-tone image							
Handling time, mc	**2416**	2424	2430	2422	**2415**	5910	5854	5920
Estimation of corr. pixels	**150723**	146976	112435	138912	138367	138876	126618	117055
Estimation of incorr. pixels	**2078**	5825	40366	13889	14434	13925	26183	35746
RMSE	**0,1166164115**	0,195247223	0,5139782717	0,30148963828	0,30734790153	0,301880112862487	0,413948777771	0,48367164437
PSNR	**18,66480653**	14,18830267	5,781104806	10,414552186	10,2473949551	10,4033099262598	7,66106790743	6,30898745443
Error of first kind	0,0056719117	0,00343642612	0,2920311087	0,01281244348	0,056776994032	**2,89383251944294E-5**	0,165860010852	0,18473503346
Specificity	0,9943280883	0,996563574	0,7079688913	0,9871875565	0,94322300597	**0,999971061674806**	0,83413998915	0,81526496654
Error of second kind	0,08877607	0,632958288	**0,001**	0,831366630	0,4518386389	0,955063117453348	0,22344950604	0,700535126235
Sensitivity	0,9112239	0,367041712	**0,999**	0,1686333699	0,5481613611	0,044936882546652	0,776550494	0,299464873765
	"37073", the colour image							
Handling time, mc	2456	2426	2433	**2409**	**2409**	5880	5832	5914
Estimation of corr. pixels	**150878**	147566	112427	139864	139101	139714	127242	117272
Estimation of incorr. pixels	**1923**	5235	40374	12937	13700	13087	25559	35529
RMSE	**0,11218287**	0,185095237	0,51402920098	0,29097367	0,2994312928	0,292655676930907	0,408986367	0,482201319
PSNR	**19,0014691**	14,6520951	5,780244178	10,722922	10,4740563	10,6728609405908	7,765823385	6,33543212473
Error of first kind	0,00798142	0,004271138	0,290221682	0,012324463	0,056668081	**3,5952341576E-5**	0,1636838207	0,18590236782
Specificity	0,99201858	0,995728862	0,7097783179	0,98767553730	0,94333192	**0,999964047658424**	0,83631618	0,814097632179
Error of second kind	0,05922203	0,338068182	**0,00087412587**	0,81752622378	0,42387820513	0,95294289044289	0,203598485	0,704763986014
Sensitivity	0,94077797	0,661931818	**0,999125874**	0,1824737766	0,576121795	0,0470571095571096	0,7964015152	0,295236013986

(Fig. 1). Improve the quality of image processing in the following ways:

1) the preliminary analysis and the handling of images depending on outcome of the analysis (a filtration, a sharpness raise, noise reduction etc.).

Thus raise quality of handling by methods of Hrjashchev, Laplacian and a mask of a method Canny;

2) introduction of images intellectual processing:

a) carrying out of the preliminary analysis of the image fragments on saturation degree their contours (it is weak, middle and strongly sated);

b) use of the cascade scheme of contours allocation taking into account a class of fragments.

On the first stage - to use a method ensuring not the admission of real contours (minimum (maximum) value of an error of second kind (sensitivity)). At the second stage - a method ensuring high localization and lack of ruptures in contours (exact allocation of boundary pixels and their unbiasedness), accordingly ensuring the minimum (maximum) value of an error of first kind (specificity) and minimum value RMSE.

For the first stage - use methods Sharu or the Laplacian (LoG), for the second stage - methods of Laplace 1, Sobel or Hrjashchev.

The method Canny on the average gives the highest value of metrics, however is not suitable for use in systems of images automatic processing.

V. Conclusion

1. The testing methods for masking the performance quantification of the image processing quality the is justified, there is no universal method of masking, which has the same high values of the metrics for images with different content of their objects (contours). It is proved that the present methods are effective only within a narrow class of images. In most cases, the evaluation of quality masking method is limited only by subjective assessment (visual assessment of the work quality).

2. The experimental evaluation of the concealment methods quality revealed the following:

a) the irrelevance of the color images for concealment methods (values of quality - no more than 8 % slightly change);

b) the best indicators of the search paths quality in the method of Sobel (on values of indicators N corr., N incorr., RMSE, PSNR);

c) the best indicators of quality in terms of non-payment of false contours in Khryashchev method with simultaneously worst values of the admission characteristics of real contours and pass of the occurrence shocks;

d) the best indicators of quality from the point of view not the admission of real contours and occurrence of borders ruptures at a method Sharu.

3. Established methodology is applicable in automatic image processing and is based on an intelligent image processing, namely:

a) on analysis of images (or fragments) on saturation degree their contours with the subsequent classification: poorly, middle and strongly sated with contours;

b) use of the cascade scheme of contours detection and allocation in images taking into account saturation degree their contours.

Application of two-cascade technology of masking images allows to reduce processing time and to raise accuracy of masking, thus allows to eliminate lacks of separately used methods with preservation of advantages and advantages of masking technology as a whole.

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