

FINDING AREAS OF TYPICAL ARTIFACTS OF IMAGE ENHANCEMENT METHODS*

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The paper presents a new method to find areas related to typical artifacts of image enhancements methods. Two artifacts are analyzed: edge blur and overshooting effect. The method is based on the analysis of basic edges — the edges which remain after performing image processing algorithms.

Introduction

Quality estimation of image enhancement methods is important for image processing. Image metrics [1] are usually used to numerically evaluate and compare results of image resampling (interpolation), image deblurring (sharpening), image deringing and other image enhancement algorithms.

Image quality can be different in different areas. For example, bilinear interpolation blurs the edges while bicubic interpolation introduces overshooting

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artifact — false edges near strong edges. Existing metrics operate with entire images and provide overall image quality estimation. There are methods for blur [2] and ringing [3] estimation, but these methods are designed for specific image enhancement algorithms.

In this work, we propose a method to find the areas on the image related to two artifacts of image enhancement methods: edge blur and overshooting effect. These artifacts are typical to image interpolation, image deblurring and image deringing methods and usually appear near sharp edges distant from other edges.

Basic edges

We use only *basic edges* — the edges which are not displaced and disappeared after image quality degradation like downsampling or blurring. The following restrictions are applied to image edges [4]:

1. An edge with low gradient value is not masked by nearby edges with high gradient value. The following rule is applied to edge points:

$$g_{i_0, j_0} > \max_{i, j} g_{i, j} \varphi((i - i_0)^2 + (j - j_0)^2),$$

where $g_{i, j}$ is the gradient modulus field, function $\varphi(d)$ is the mask function. We

use $\varphi(d) = h e^{-\frac{x^2}{2d^2}}$, where $h = \frac{1}{d\sqrt{2\pi}}$.

2. The distance from the edge point to the closest edge is greater than a predefined threshold $r_T = 2d$. If the distance between two edges is less than r_T , the edges will be displaced. We use mathematical morphology to find the edges which pass this condition [4].

3. The gradient value is greater than a given threshold.

Parameter d is the factor which depends on the image degradation method. For image interpolation we use d equals to the scale factor, for ringing suppression d is the width of a single ringing oscillation, for image blur by Gauss filter with radius σ we use $d = \sigma$.

Detection of the areas of interest

We consider the areas related to the following artifacts of image enhancement algorithms: blur artifact which appears in basic edge areas and ringing artifact (overshooting) in the areas of edge neighborhood.

We define as *basic edge points* (BEP) the set of points with the basic edge as the closest edge and the distance to it less than $\frac{d}{2}$.

Basic edge neighborhood (BEN) is formed by points with the distance to the closest edge point between $\frac{d}{2}$ and $d\left(\frac{1}{2} + s\right)$, where parameter s is defined by the number of ringing oscillations. We use $s = 2$.

The results of basic edges and areas of interest detection are shown in figure 1.

Conclusion

A new method to find areas related to typical artifacts of image enhancements methods has been developed. It can be used in cooperation with image metrics to estimate the quality of image enhancement methods.



a) Original image.

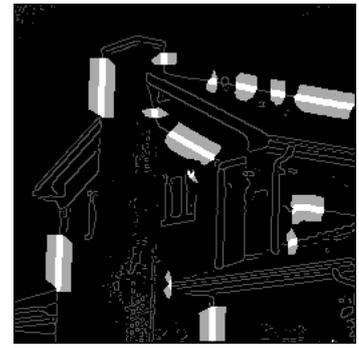


b) finding basic edges:

white edges are basic

edges, gray edges are non-

basic non-masked edges.



c) BEP (white) and BEN

(gray) areas.

Fig. 1. The result of basic edges and areas of interest detection.

References

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