# Artifacts: False Contours Detection and Smoothing

**Andrey Zakharoff**
Dept. of Software, ZAO "Komplex-Pro", Moscow, Russia
zakharoff1@gmail.com

***Abstract:*** *As a result of significant JPEG or MPEG loss compression and decompression some specific artifacts may turn up on an image, such as false contours or blocks of quadrates, they especially become ugly visible when the image is stretched on a bigger size of HDTV-panel.*
*In the work these artifacts are detected, and their visual perception reduced by smoothing, while saving natural edges untouched. The task of detection is completed with general histogram analyzing and it's comparison with some local features on the image. Also a measure of false edge smoothing efficacy is suggested and demonstrated with different combination of smoothing methods.*

***Keywords:*** *false contours, blocks artifacts; smoothing efficacy; histogram analisys.*

## 1. Introduction

In [1] it was considered the problem of false contours in HDTV. Main supposed technique - to preprocess image with dithering before compression, and this way saving information from full bit depth losing(re-quantizing). Unlikely, here we mean only post-processing with the given image.

In [2] authors estimated entropy and other statistical moments of secondary in local windows and after thresholding found difference between flat regions and regions, containing real edges. Then methods of removing false contours were applied, such as random pixel shuffling, low pass filtering and error diffusion. Two of these methods also used here, with some more analysis. But at the time of co-working presented method showed off its priority in accuracy of artifact detecting.

It was difficult to compare this method with that of [3] due to different sample base and different time of research.

In [4] authors use edge regeneration, while in present work only passive approach of accurate false edges smoothing on probably flat area were used. But main difference of suggested algorithm from previous- accumulating global image information in luminance histogram and comparing it with local features in small sliding window. It gives significant less probable false positive error leading to image degradation.

United with another case of artifact- blocks, and general solution is suggested.

## 2. Observed Histogram Peculiarities of Images with the Mentioned Artifacts

Normal image histogram has smooth, unbroken form, as seen at Figure 1. Here we mean histogram of brightness, or intensity values Y. Figure 2 represents block artifacts, it was undergone to strong JPEG compression with blocked cosine transforms. Apparently, the histogram (bottom of Figure 2) has the regular spike structure.

Similarly, frames from movies in MPEG reveal likely artifact- false contour, the histogram represents near periodic slit (chinked) structure (Figure 1c).

This artifact become visible on a big size panel.

## 3. Global processing part of the algorithm: collecting and analysis of whole image

The analysis is sufficient to be done only for Y-component, it is calculated from R, G, B components or taken from Y-C-C data directly according all-known formulae.

Accumulated histogram is divided onto intervals of several bins. Several steps are made:

1) Spikes are define relatively to some threshold level, they should be >0.5,...,0.7;
2)they are saved in bool-type array;
3)the most probable period is defined (generally it can slightly vary);
4) first shift (from 0 value) also to be defined.

The word "spike" should be replaced for word "slit" for false contouring artifact.

## 4. Local analysis

Small (5x5 pixels typically) window scan the image from the left to right and from the top to bottom, while analyzing it at mark the mask when this pixel considered to be smoothed, what furthermore is depicted with red color.

Having separated the histogram into zones B(i) during global stage of processing, so far we can analyze the image locally with the sliding window 5x5.

Figure 3 represent all patterns, which can meet in the window. Let's specify 2 cases, interpreted as "artifact", and 2 case "non-artifact":

Case 1. All pixels within the window belong to one histogram interval B(i)<=Value<B(i+1), this is a flat region. The algorithm decision- smooth it as an artifact, despite it is not ground truth artifact.

Case2. All inside pixels belong to two adjacent intervals so that B(i-1) <= Value < B(i+1) and border length between them l<m+ n, where m, n - size of the window. Decision- actual artifact, to be smoothed.

Case 3. Pixels of more than two segments, or of two segments, but not adjacent, met together. Decision-not artifact, central pixel remain in the same value.

Case 4: Pixels of two adjacent segments of histogram met, as in case 2, but dividing border has the length l> m+n, - it is typical pattern of fine textured fields. Decision- non- artifact, stay untouched.

## 5. Emerging of Smoothed areas. Erosion and Dilation

At the Figure 4 there is a sample with revealed false contour area: the case 1 was marked with green color, and the case 2 with red. They are to be smoothed. Method qualifies real edges to cases 3 and 4, they remain untouched - they are face contours, eyes, silhouette, and high textured zone.

To remove small insignificant areas and additionally protect real edges from smoothing, operations of erosion and dilation
are consecutively applied. Erosion here is in the meaning to erode (shrink) area to smooth. At the Figure 5 case 1 and 2 united and shown in red only, first one-'a' in the set is bare found area to smooth, then erosion-'b' (with processing window 11X11 ) is applied, then dilation (7x7)-'c'. Should be mentioned, this picture represents the case of blocks-artifact rather than false contours.

## 6. Smoothing Methods and It's Effitiency Estimation

Originally false contour reduction was implemented with inserting additional level between false edges of average value, as shown at Figure 6. In images, corrupted with posterizing, it duplicated the contour amount and gave positive visual effect, Figure 9.

Now for generality we apply multi-run over the picture with smoothing filters- arithmetically mean, Gaussian, shuffling. Multi-run processing was undesirable in past, but with current in-GPU parallel processing technology this approach became affordable.

At triadic Figure 7 samples of gradation ramp of gray, it's histogram and it's luminance value versus length are presented from the right to left. "SD" stands for "standard deviation" of values from inclined straight line, built with least squared method. This line shows a plot of value of ideal ramp, which we try to get as a result of smoothing vertical strips. We have chosen vertical strips for clearness, since effect for horizontal or diagonal strips smoothing with quadratic kernel would be the same, but less comprehensive. So we suggest this method as an efficiency measure for different kind of smoothing. It should be specified, horizontal size of the kernel should be less or equal to strip width. This group of pictures shows dynamics of multi-run smoothing process.

Calculated SD demonstrates the effectiveness of our smoothing technique. It is visually apparent, and the effectiveness is calculated as

$$Eff= [(SD_o- SD_{res})/SD_o]*100\%,$$

where $SD_o$ is SD of original stripped ramp, and $SD_{res}$ is one of resulting. 100% effectiveness corresponds to the case of in some different filters combinations with increasing of runs amount. Apparently, the bottom row of pictures shows, after one shuffle, five Gauss and one mean averaging 88% effectiveness was achieved, and original strips visually can hardly be noticed. While several Gauss filter applying, the base of the filter was enlarged minimally, so that final width would not exceed strip width, otherwise it's multi-applying would be inefficient. Figure 8 shows source image with block artifacts another time for comparison (left) and processed (1 shuffle+5 Gauss+1 mean) result according the method.

Effect is more visible on a large-size images (see fig.6).

## 7. Conclusions

At figure 8 result of false contour detecting and multiple smoothing is presented. Here it were one shuffling and 5 enlarging Gaussian averaging applied consecutively. The result is not very accurate, especially on the border between false contour and real edge area. But main part of the image somehow improved in whole visual perception. Some small details stayed untouched while block artifacts also still present, but here we propagate the idea of delicate processing.
In case of pure posterizing the method of contour doubling gave visually essential improvement, as shown at figure 9.

Also a method of numerical estimation for smoothing efficiency was suggested via standard deviation of horizontal staired gray ramp, which has been smoothed with different methods at figure 7.

## 8. References


[1] S. Daly and X. Feng, “Decontouring: prevention and removal of false contour artifacts,” in SPIE Human vision and Electronic Imaging IX, San Jose, CA, June 2004, vol. 5259, pp. 130-149.

[2] Wonseok Ahn and Jae-Seung Kim, “Flat-region detection and false contour removal in the digital TV display,” in ICME, July 2005, pp. 1338-1341.

[3] Ning Xu, Yeong-Taeg Kim, "A Simple and Effective Algorithm for False Contour Reduction in Digital Television", IEEE Digital Media Solutions Lab, Samsung Information Systems America, Inc., Irvine, CA,2010.

[4] S. Alireza Golestaneh and Damon M. Chandler, "Algorithm for JPEG artifact reduction via local edge regeneration", Journal of Electronic Imaging 23(1), 013018 (Jan–Feb 2014).

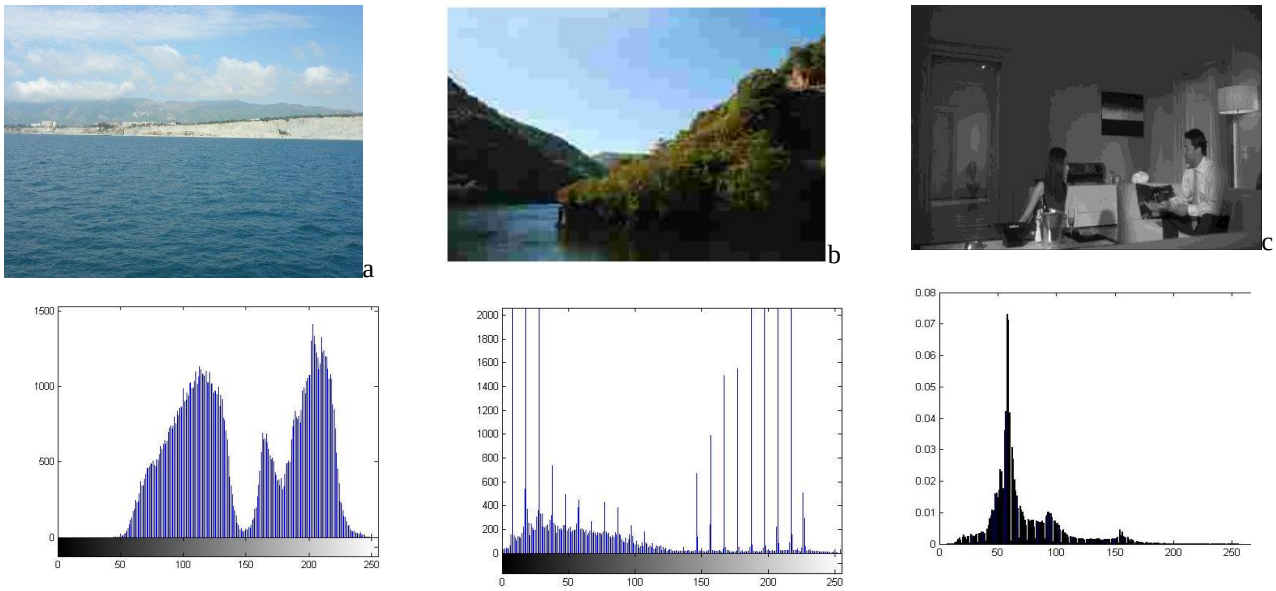



**Figure 1 - Images (above) and their histograms: a- normal, b-spikes-form, c- chinked-form**

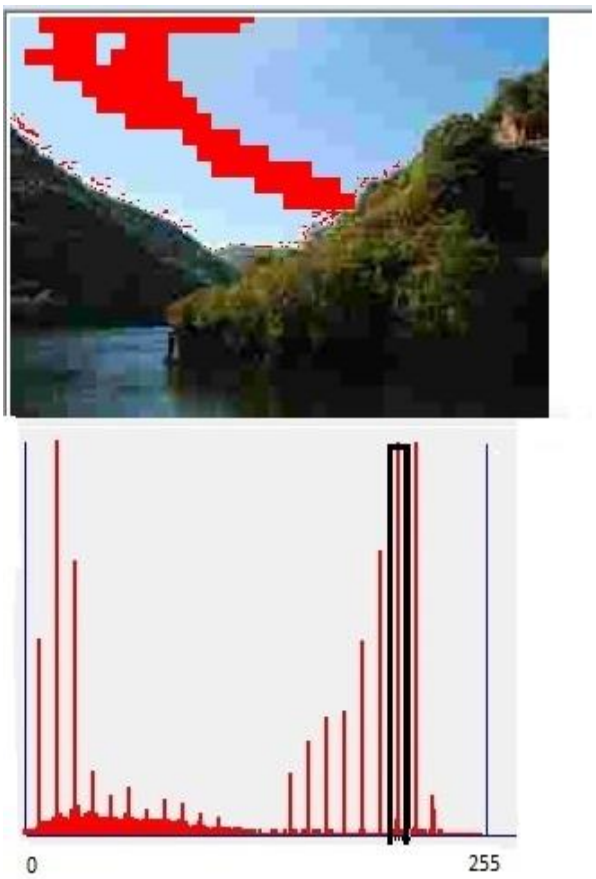



**Figure 2 - One zone selected on the picture (top) and corresponding spike on the intensity histogram (bottom).**

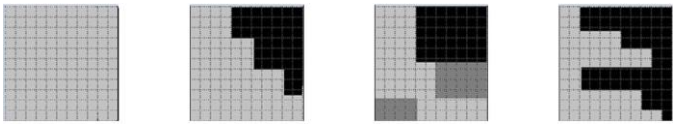


**Figure 3 - Four kinds of patterns to qualify false contours.**

**Figure 4 - Case 1 (flat region)-marked as green, and case 2 (false contour)-as red. Both regions are to be smoothed. Real edges stay untouched**

**Figure 5 - Segmented image marked as red: a- found area for smoothing, b- eroded, c- dilated.**

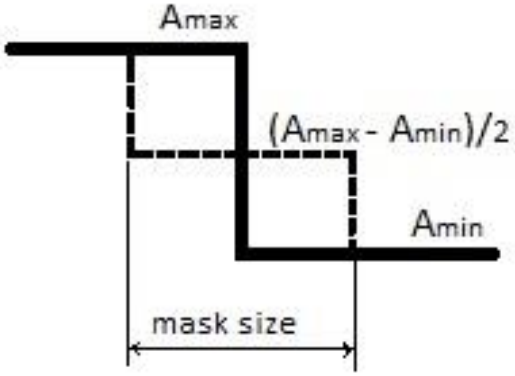
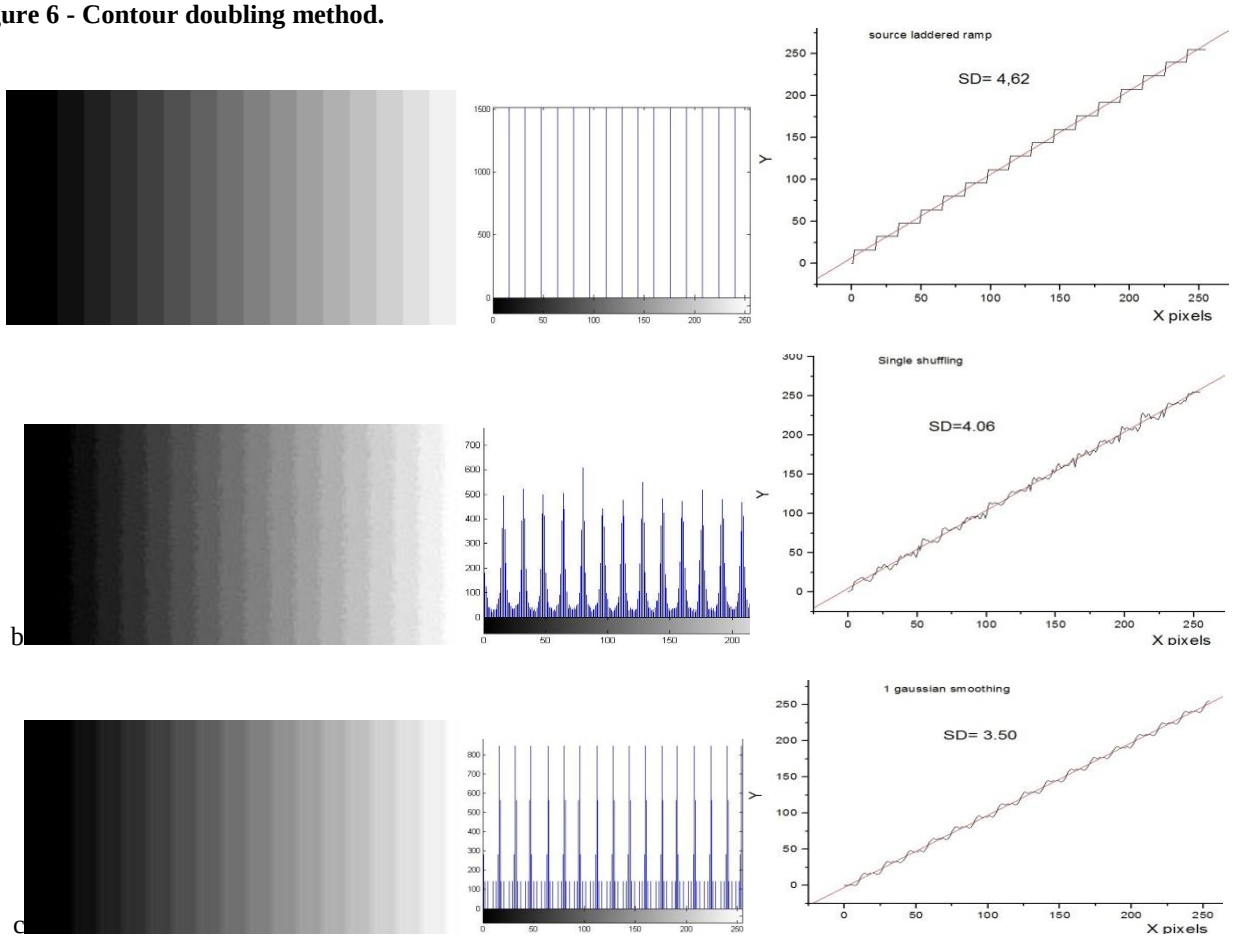



**Figure 6 - Contour doubling method.**



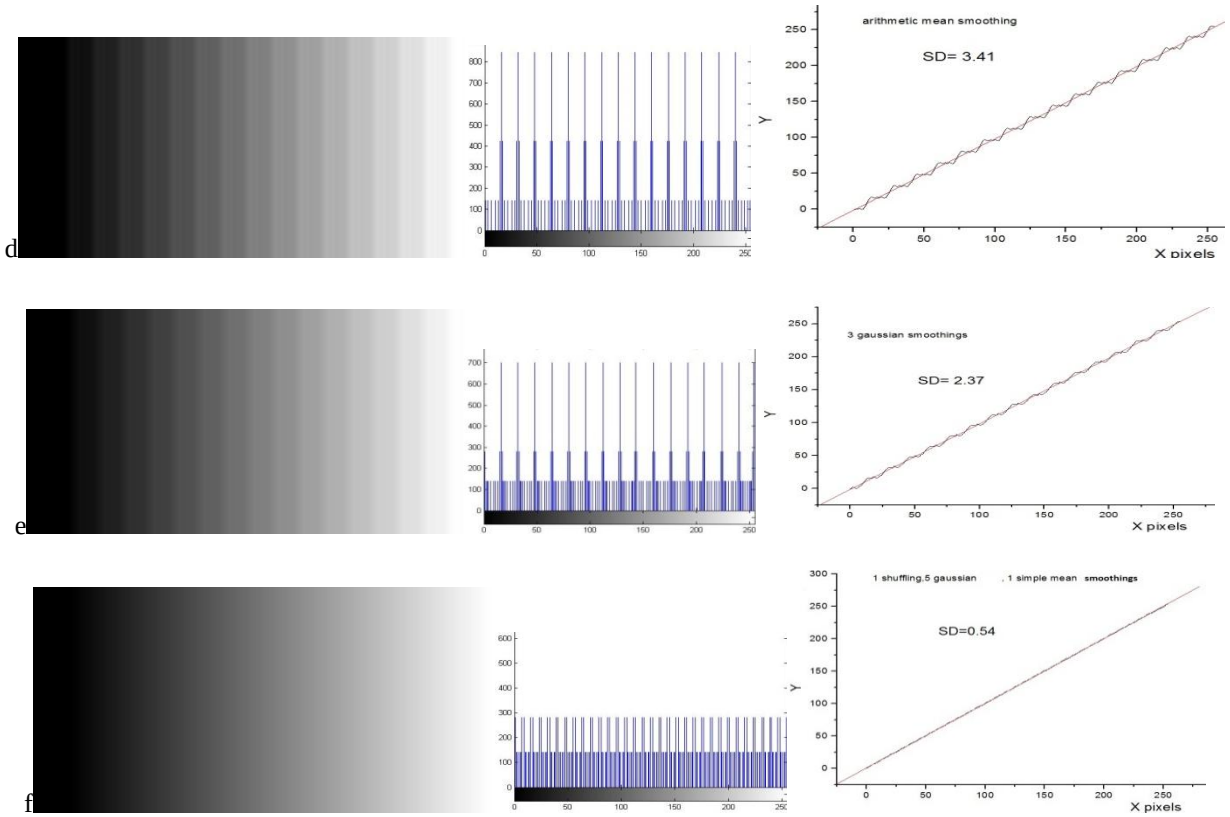



**Figure 7 - Staired smoothed ramp, it's histogram and horizontal intensity plot: a- initial; b-single shuffling; c- Gaussian smoothing; d- mean smoothing; e- 3-fold Gaussian smoothing; f- 1- shuffling, 5 Gaussian plus one mean smoothing. "SD" stands for standard deviation**

**Figure 8 - Initial picture with artifact (top) and result of multifold processing( bottom)**

**Figure 9 - Initial posterized picture (left) and processed with contour doubling method**