A Comparative Analysis of Different Techniques for removing Artifacts from Graphical Images

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ABSTRACT
In graphical images after compression there are certain problems arises like blocking artifacts, removal of information etc. Blocking artifacts degrades the images by making regular blocks in images. The image will not appear smooth. In this paper we are making comparison between different image processing techniques like spatial filtering, localized and Adaptive. The comparison is made on the basis of different parameters like mean square error, peak signal to noise ratio, bit error rate and the visibility of image. Out of these techniques adaptive technique shows good results. It smoothes the artifacts more in comparison to others.

Keywords
Block discrete cosine transforms, blocking artifacts, PSNR, BER and MSE

1. INTRODUCTION
One of the most noticeable significant problems in DCT Based image is Blocking Artifacts, which is the introduce distortion of image Quality. Compression artifact (or artifact) is a noticeable distortion of media (including images, audio, and video) caused by the application of lossy data compression. This noticeable degradation of blocking effect is “blocking artifact” which shows the regular pattern of visible block border. If the compressor could not reproduce enough data in the compressed version to reproduce the original, the result is a diminishing of quality, or introduction of artifacts. Transform from spatial domain to frequency domain is the basic operation. So, this will affect the judgment of an observer. There are the DCT coefficients are available in DCT-domain image/video processing methods, it would be advantageous to measure the quality of image/video in the DCT-domain. For this process there are many bit-streams processing algorithms which are applied directly to the DCT domain have been developed to avoid the process of decompression and compression. In this paper, Compared to other spatial domain algorithms, the DCT-domain also takes advantage to reduce the Computation complexity significantly, which is important for real-time applications.

In this paper, we have discussed a spatial filtering method for reducing the blocking artifacts in transformed images. In order to reduce blocking artifacts, measurement of blocking artifacts is very necessary. Various methods are proposed to measure the blocking artifacts in compressed images. Some method can be implemented only in the pixel domain and therefore requires DCT/IDCT operations. To propose a blind but accurate measurement algorithm by taking into account that the change in pixel value cross block boundary is large as compared to adjacent pixels as we move away across block boundary. Our method takes advantage of the fact that some of the DCT coefficients of a step function (a sharp edge) have nonzero values [1].

$$F_b(u,v) = C_u C_V \sum_{k=0}^{N-1}\sum_{l=0}^{N-1} b(k,l) W_{DTC}(u,k) W_{DCT}(v,l) \qquad (1)$$

Where b(k,l) is the intensity of the (k,l) pixel in b, bu , bv and WDCT are given by [1]

$$b_u, b_v = \frac{1}{\sqrt{N}} \; for \qquad u = 0, v = 0 \qquad (2)$$

$$b_u, b_v = \frac{\sqrt{2}}{\sqrt{N}} \qquad otherwise$$

A novel method to remove blocking artifacts is localized DCT-based filter. It considers the condition of similarity between adjacent blocks [2]. A localized fuzzy filter is utilized to avoid blurry effect of linear filter and to overcome ringing effect.

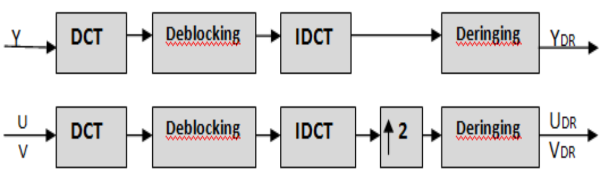


Figure 1. Technique for localized fuzzy filter

Figure 1 shows the whole algorithm. First of all, entire components are transformed into DCT domain and with the help of localized non linear filters are deblocked. We use IDCT transform to convert back into pixel domain. Then the deblocked Y component is implemented to form the coefficients at the localized fuzzy filter which is used for removing ringing effects. U and V components are unsampled to the same size of Y component then are deranged by the localized fuzzy filter from luma [2].

A new method was proposed which is non iterative blocking artifacts reduction method for block discrete cosine transform compressed images. Bilateral filter smooth's out the blocking artifacts by weighted averaging of the pixel values without smoothing the edges [9]. The output of a bilateral filter at spatial position k is given by

$$Z(k) = \frac{1}{F} \sum_{m \in \tau(k)} e^{\frac{-\|m-k\|}{2\sigma_s^2}} e^{\frac{-\|z(m)-z(k)\|}{2\sigma_i^2}} Z(m) \quad (3)$$

where σ_s and σ_i control the weights in spatial and intensity domains.

$$F = \sum_{m \in \tau(k)} e^{\frac{-\|m-k\|^2}{2\sigma_s^2}} e^{\frac{-|z(m)-z(k)|^2}{2\sigma_i^2}} \quad (4)$$

where F is the normalization factor and Γ(k) is a square window centered at Z(k).

The bilateral filtering performance depends on two filter parameters σ_s and σ_i, which affects the filtering results. This parameter controls the weights in spatial and intensity domains [9].

2. PARAMETERS USED

In this paper I have used three parameters. First one is Mean Square Error; second other is Peak Signal to Noise Ratio and third is Entropy.

(i) Mean Square Error (MSE)

$$\text{MSE} = \frac{1}{MN} \sum_{j=1}^{M} \sum_{k=1}^{N} \left(x_{j,k} - x'_{j,k} \right)^2 \quad (5)$$

where, M and N are rows and columns, respectively of the image. $x_{j,k}$ is the original image and $x'_{j,k}$ is the corresponding output image. The MSE should be less, which means that the pixel intensity of the input and output image should be as close as possible.

(ii) Peak Signal to Noise Ratio (PSNR)

$$\text{PSNR} = 10 \log_{10} \frac{255^2}{MSE} \quad (6)$$

Peak Signal to Noise Ratio should be as large as possible which means that the content of signal in the output is large and the noise is less. Since it is peak signal to noise ratio that's why the value of the signal is considered as maximum which is 255 (for gray scale images the gray scale ranges from 0 – 255).

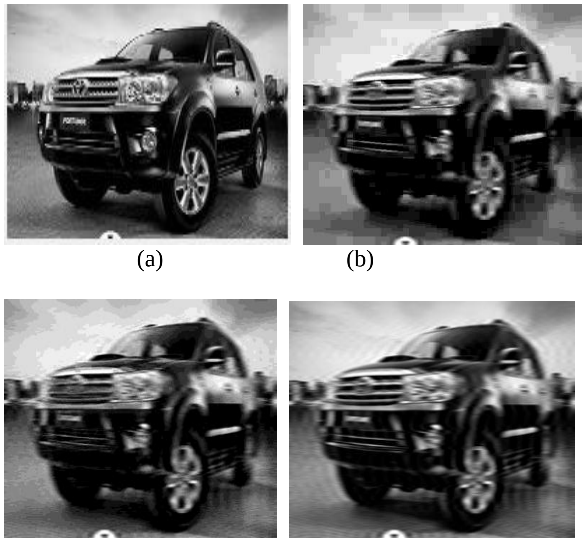
(iii) Bit Error Rate (BER)

$$BER = \frac{1}{PSNR} \quad (7)$$

- the number of bit errors is the number of received bits of a data stream over a communication channel that have been altered due to noise, interference, distortion or bit synchronization errors.

3. RESULTS AND DISCUSSION

The spatial filter, localized and adaptive filtering technique is applied on gray scale images.



(a) (b) (c) (d)

Figure 2. (a) Big Car Original Image, (b) Spatial filtered image(c) localized image (d) adaptive filtered image.

Table 1. Shows the parameter results of Spatial filter applied on big car original image

	Quality Factor	**Spatial Filter**		
		PSNR	**MSE**	**BER**
Big Car	0	0.488	22.33	2.04
	50	21.31	22.33	0.04
	100	26.93	22.33	0.03
	150	30.31	22.33	0.03
	200	32.74	22.33	0.03
	250	34.64	22.33	0.02

The table shows that peak signal to noise ratio is maximum for spatial filter. Also as the quality factor increases the peak signal to noise ratio also increases. The mean square error and bit error rate is also less for spatial filter. The spatial filter also removes blocking artifacts from the image. But the blocking artifacts are not removed totally.

Table 2. Shows the parameter results of Localized filter applied on big car original image

	Quality Factor	Localized Filter		
		PSNR	MSE	BER
Big Car	0	3.591	10.93	0.27
	50	24.41	10.93	0.04
	100	30.03	10.93	0.03
	150	33.41	10.93	0.02
	200	35.84	10.93	0.02
	250	37.74	10.93	0.02

The table shows that peak signal to noise ratio is maximum for adaptive filter in comparison to spatial and localized filter. Also as the quality factor increases the peak signal to noise ratio also increases which is again maximum for adaptive filter. The mean square error and bit error rate is also less for adaptive filter. The adaptive filter also removes blocking artifacts from the image in comparison to other filters.

Table 3. Shows the parameter results of Adaptive filter applied on original image

	Quality Factor	Adaptive Filter		
		PSNR	MSE	BER
Big Car	0	16.80	0.522	0.05
	50	37.62	0.522	0.02
	100	43.24	0.522	0.02
	150	46.62	0.522	0.02
	200	49.05	0.522	0.02
	250	50.95	0.522	0.01

The table shows that peak signal to noise ratio is maximum for adaptive filter in comparison to spatial and localized filter. Also as the quality factor increases the peak signal to noise ratio also increases which is again maximum for adaptive filter. The mean square error and bit error rate is also less for adaptive filter. The adaptive filter also removes blocking artifacts from the image in comparison to other filters.

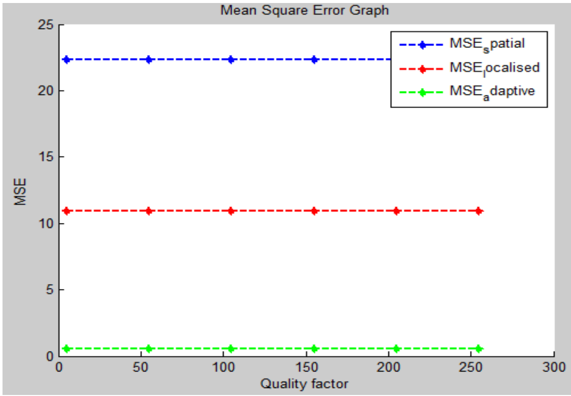


Figure 3. Graph shows the comparison between mean square error of different filters.

As it is clear from graph results that the artifacts are removed to some extent and it has increased the quality of the images. Again the graph shows that the mean square error is minimum for adaptive filter and maximum for spatial filter

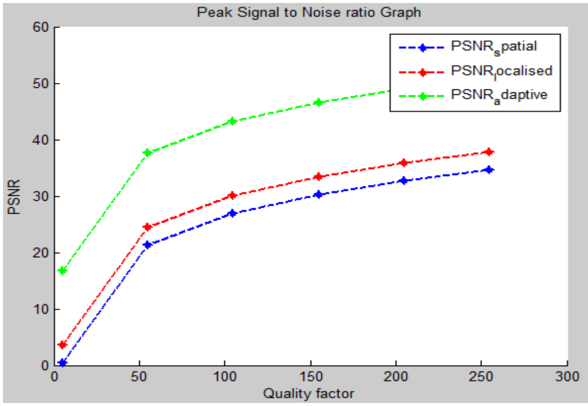


Figure 4. Graph shows the comparison between peak signal to noise ratio of different filters.

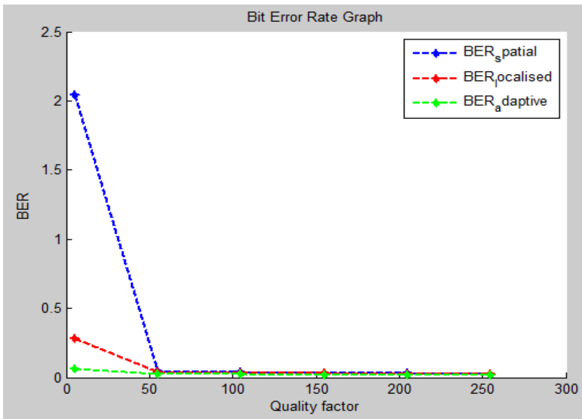


Figure 5. Graph shows the comparison between bit error rate of different filters.

Finally, it is clear from graph results that the artifacts are removed to some extent and it has increased the quality of the images. The graph shows that the peak signal to noise ratio is maximum while mean square error and bit error rate is minimum for adaptive filter.

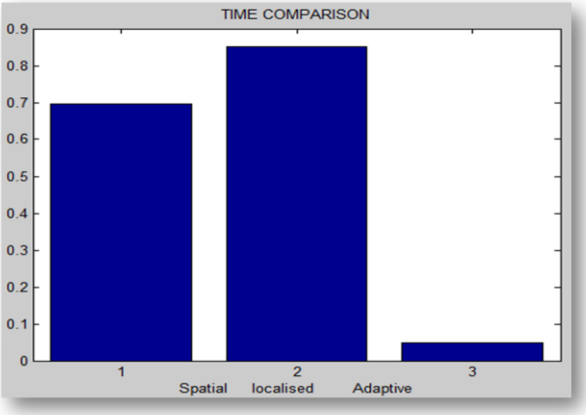


Figure 6. Graph shows the Time Comparison between different filters.

Also the adaptive approach takes less time to compute the results in Comparison to other approaches like spatial and localized method.

4. CONCLUSION

In this paper we have made comparison between three different techniques for removing blocking artifacts from the gray scale images. The adaptive technique performs better in comparison to spatial and localized filtered approaches. Also the adaptive approach takes less time to compute the results in comparison to other approaches. In future we can extend our research to modify the filter to show better results so that blocking artifacts can be reduced further.

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