Performance And Analysis Of Compression Artifacts Reduction For Mpeq-2 Moving Pictures Using Tv Regularization Method

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Abstract: Novel approach method for the reduction of compression artifact for MPEG–2 moving pictures is proposed. Total Variation (TV) regularization method, and obtain a texture component in which blocky noise and mosquito noise are decomposed. These artifacts are removed by using selective filters controlled by the edge information from the structure component and the motion vectors. Most discrete cosine transforms (DCT) based video coding suffers from blocking artifacts where boundaries of (8x8) DCT blocks become visible on decoded images. The blocking artifacts become more prominent as the bit rate is lowered. Due to processing and distortions in transmission, the final display of visual data may contain artifacts. A post-processing algorithm is proposed to reduce the blocking artifacts of MPEG decompressed images. The reconstructed images from MPEG compression produce noticeable image degradation near the block boundaries, in particular for highly compressed images, because each block is transformed and quantized independently. The goal is to improve the visual quality, so perceptual blur and ringing metrics are used in addition to PSNR evaluation and the value will be approx. 43%.The experimental results show much better performances for removing compression artifacts compared with the conventional method.

[M.Anto bennet, I. Jacob Raglend. **Performance And Analysis Of Compression Artifacts Reduction For Mpeq-2 Moving Pictures Using Tv Regularization Method.** *Life Sci J* 2013;10(2):102-110]. (ISSN: 1097-8135). http://www.lifesciencesite.com. 16

Key words: Total Variation (TV) regularization method, compression artifacts, Mosquito Noise, Blocky noise, PSNR (Peak Signal-Noise Ratio), De blocking edge filter, DCT (Discrete Cosine Transform),Video coding, MPEG compression

1.INTRODUCTION

MPEG International Standard has been used as formats for compressing and storing still images and moving respectively. In this paper, we propose a new noise removable method utilizing the TV regularization method for moving pictures compressed by MPEG-2.We have proposed different TV regularization approaches for MPEG compressed image, one is to remove a blocky noise effectively and the other is to remove a mosquito noise which combine these two methods and apply for moving pictures.MPEG-2 has been a widely accepted video standard for various applications ranging from DVD to Digital TV Broadcast. A large variety of products based on the MPEG-2 standard are available in the market. The most important goal of MPEG-2 was to make the storage and transmission of digital AV material more efficient. The new H.264 AVC standard has an even broader perspective to support high and low bit-rate multimedia applications on existing and future networks. The advantage in terms of better quality at a lower bit rate is why H.264 is fast replacing MPEG-2.Blockiness the most prevailing artifact in block discrete cosine transform (DCT) code image and video under low bit-rate conditions, due to the independent transformation and quantization of image blocks.

The DEF (Deblocking Edge Filter) method used to reduce the blocky noise. In this, blocky noise and mosquito noise are removed efficiently without losing edge components. However, as a result of removing DCT noise, the small texture components are also removed at the same time. In the DCT-based compression methods such as JPEG, MPEG and H.264, the compression artifacts occur by quantization of DCT coefficients. The quantization of low frequency coefficients generates blocky noise, and the quantization of high 0frequency coefficients generates mosquito noise.

When the data transmission channel bandwidth is narrow, the data rate is lowered and quantization level is dropped. As a result, the compression artifacts are increased. In DCT coding, the original image is divided into blocks, and the DCT is processed in each block, integrating signals in all blocks into low bands and quantizing the DCT coefficients so that compression performance can be increased. However,higher the compression rate is set, the lower the quality of reconstructed images because of increased blocky noise. This is because there are no correlations between blocks as a result of quantizing low band signals, and since the high band signals are quantized, reconstructed images become blurry and include mosquito noise.

The remarkable phenomenon is that all blocky noise and mosquito noise are separated into the texture component. Several post-processing methods have been applied to remove these artifacts. Our method achieves efficient reduction of blocky noise and mosquito noise without texture component lost. The usual TV will be changed in a weighted TV that regularizes blocks' edges without regularizing images' true edges. Although the algorithm converges in infinite time, one obtains best PSNR with a very few number of illustrations, leading therefore to a fast method.

2.EXISING METHOD

MPEG–2 is widely used to compress moving pictures in the DVD and the digital television broadcast. One of problems of MPEG–2 is the compression artifacts such as blocky noise and mosquito noise which occurs when the compression ratio is high and picture motion is large. These artifacts sometimes becomes problems in the terrestrial digital HDTV broadcast because its transmission channel is not wide enough to send non-artifact MPEG–2 picture. In one of the most effective methods for removing these artifacts, there is the ADF method, which was proposed by (Alter et al., 2005)In this method the Total Variation (TV) regularization approach is introduced to remove artifacts. The total Variation is minimized under the constraint condition for quantized DCT coefficients. This method removes compression artifact efficiently without losing edge sharpness. However, the blocky noise reduction is not enough at low bit rate, and the original texture component is removed together with the compression noise.

We have proposed different TV regularization approaches for JPEG compressed image, one is to remove a blocky noise effectively (Goto et al.,2009) and the other is to remove a mosquito noise. We propose a new method which combine these two methods and apply for MPEG–2 moving pictures. (Kato et al., 2011)**.**The superiority of the technique has been demonstrated over the existing MPEG method with and without its deblocking filter. As simulations have indicated, the technique would be particularly appropriate for low-bit rate videos. Lastly, the technique is also suitable for other DCT based standards such as MPEG and JPEG .Block DCT coding has been successfully used in image and video compression applications due to its energy compacting property and relative ease of implementation.

After segmenting an image into blocks of size NxN, the blocks are independently DCT transformed, quantized, coded, and transmitted. One of the most noticeable degradation of the block transform coding is the "blocking artifact." These artifacts appear as a regular pattern of visible block boundaries. Transform coding is the heart of several industry standards for image and video compression. In particular, the discrete cosine transform (DCT) is the basis for the JPEG image coding standard, the MPEG video coding standard, and the ITU–TH. 261 and H.263 recommendation's for real time visual communication. However BDCT has a major drawback which is usually called blocking artifacts. In order to reduce blocking artifact, measurement of blocking artifact is very necessary. Several methods have been proposed to measure the blocking artifacts in compressed images.

A new model was obtained that gives the numerical value depending upon the visibility of the blocking artifacts in compressed images and thus requires original image for comparison with reconstructed image. In practice the original images will not be available. In the blocky image is modeled as a non blocky image interfering with a pure blocky signal. Blocking artifacts measurement is accomplishedby estimating the power of blocky signal. The weakness of is to assume that the difference of the pixel value in block boundary is caused only by blocking artifacts. This assumption decreases computation complexity but the measured value does not confirm to truth for the two adjacent blocks with a gradual change in pixel value. The variation of pixel value across block boundary was modeled as a linear function. This method is not accurate especially for the adjacent block with a large change of pixel value across the block boundary.

Over the past several years, many techniques have been applied to reduce the blocking artifacts in block DCT coded images. Two approaches are generally adopted. In the first approach, the reduction of blocking artifacts is carried out at the encoding side but the methods based on this approach do not conform to the existing standards such as JPEG and MPEG. In the second approach, the reconstructed image is post processed aimed at improving its visual quality without any modification in the encoding or decoding mechanisms, making it compatible with the aforesaid coding standards. Because of this advantage, most of the recently proposed algorithms follow the second approach. Post processing of the decoded image may be carried out in spatial domain or in frequency domain(singh et al.,2010).

Blockiness is the most prevailing artifact in block discrete cosine transform (DCT) code image(Pennebakar et al.,2007) and video (zhai et al.,2008)(Mitcheel et al.,2007)(wiggand et al.,2006)under low bit-rate conditions, due to the independent transformation and quantization of image blocks. In order to ameliorate the perceptual picture quality, numerous blockiness reduction algorithms have been proposed during the last two decades. Analytically, the blockiness artifacts can be divided into two categories(Al-fohoum et al.,2006)(Lee et al.,2005)(Rao et al.,2005)the grid noise in monotone areas and the edge related artifacts, such as staircase noise along edges, ringing around strong edges and corner outliers. The grid noise in monotone area, which is often referred to as "blockiness" in general sense, is a kind of structural artifact. It attracts much human attention and is thus the most annoying artifact(Wu et al.,2005). And that is the reason why most deblocking algorithms deal with grid noise only. However, since edges are fundamental cognitive clues in image for a superior perceptual quality, the edge-related artifacts should also appropriately addressed.

3.MATERIALS AND METHOD

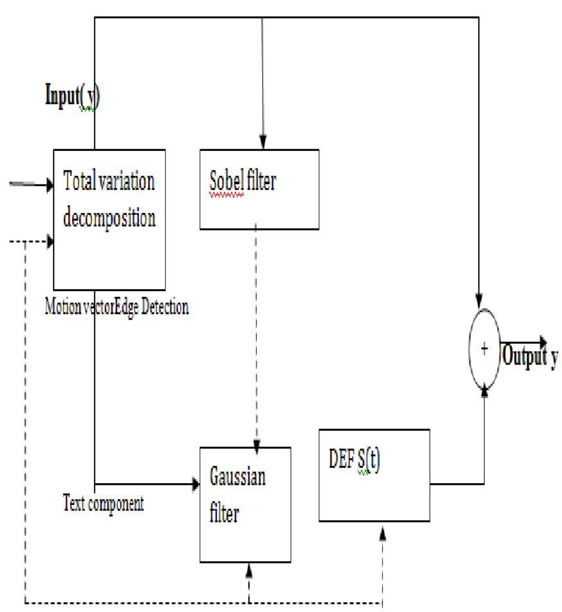


Figure 1: Block diagram for TV Regularization

TV Regularization decomposition, Motion compensation, Sobel Filter, Gaussian Filter& DEF are used in Figure 1. MC is the use of motion vectors to improve the efficiency of the prediction of peel values. The prediction uses motion vectors to provide offsets into the past and/or future reference pictures containing previously decoded peel values that are used to form the prediction error signal.

The Sobel filter consists of two kernels which detect horizontal and vertical changes in an image. If both are applied to an image, the results can be used to compute the magnitude and direction of the edges in the image. The Sobel operator is used in image processing, particularly within edge detection algorithms. Technically, it is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function.

At each point in the image, the result of the Sobel operator is either the corresponding gradient vector or the norm of this vector. The Sobel operator is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical direction and is therefore relatively inexpensive in terms of computations. In electronics and signal processing, Gaussian filter is a filter whose impulse response is a Gaussian function. Gaussian filters are designed to give no overshoot to a step function input while minimizing the rise and fall time. This behavior is closely connected to the fact that the Gaussian filter has the minimum possible group delay. DEF is one of the most well-known methods of reducing blocky noise, In DEF, by filtering both sides of 2 pixels between the blocks in the reconstructed images with blocky noise, blocky noise is smoothed out.

A stream compressed by MPEG-2 is decomposed into the structure component and texture component by using the regularization. And all signals in the structure component are filtered by using sobel filter, and threshold is set to extract edge components. As a result of using the proposed method, the blocky noise and mosquito noise are removed with edge preservation.

4. REGULARIZATION METHOD

Novel approach method for the reduction of compression artifact for MPEG–2 moving pictures is proposed. We utilize the Total Variation (TV) regularization method, and obtain a texture component in which blocky noise and mosquito noise are decomposed. These artifacts are removed by using selective filters controlled by the edge information from the structure component and the motion vectors. The experimental results show much better performances for removing compression artifacts compared with the conventional method.Modern consumer television sets need a high quality format conversion, image enhancement, and artifact reduction. Especially artifacts due to block based coding schemes may degrade image quality and make artifact reduction mandatory. A promising approach to high quality filter design is given by formulating the filter task via a variation problem and use partial differential equations to solve it. Here the design of a generalized total variation regularization filter is described. This filter can be applied in many video signal processing steps in consumer television as pre-or post-processing filter, for example as pre-processing filter prior to a motion estimation to improve image quality or analysis results. The usage in coding artifact reduction without knowledge of decoding parameters is presented in greater detail and some results are presented.

5. MOSQUITO NOISE

Mosquito Noise is a temporal, statistically random appearance of flicker in individual pixels along image edges of consecutive frames of a video. The noise level in the areas that are along the edges is significantly higher than in other areas of the image. Pixel flicker has to last over a number of consecutive frames for that to be recognized as MN. MN appears particularly along slow moving edges. This is a consequence of two major shortcomings of common video coding algorithms: ringing and motion compensation. MN can be described as a temporal subset of these two spatial video coding artifacts.

The major manifestation of MN is the change of pixel luminance values between consecutive frames, but in colour images MN can also appear and is then characterized by a colour flicker of pixel values in small spatial areas, generally not in a larger extent than one or two pixel sizes

Spatial Aspect of Mosquito Noise

The major cause of MN is ringing, which an artifact is resulting from compression algorithms implemented in video codecs. MN mainly originates in I-frames inside the Group of Pictures (GOP) and in residual coding of motion compensated frames. With increasing compression rate accompanied by an increasing quantization of coefficient values (e.g. coefficients of the discrete cosine transformation) of the transformed blocks, undershoots and overshoots of pixel values also referred to as ripples along image edges increase and will be visible in the image.

Temporal Aspects of Mosquito Noise

The second reason for the appearance of MN is motion compensation (MC) that is used in current codecs. On the one hand MC performs a great service in order to reduce the bandwidth needed to broadcast video or to reduce storage requirements; on the other hand this technique introduces new video artifacts and MC shifts and spreads already existing artifacts (like ringing) inside the image space of consecutive frames.

It occurs when reconstructing the image and approximating discarded data by inversing the transform model (IDCT)."Mosquitoes" can also be found in other areas of an image. For instance, the presence of a very distinct texture or film grain at compression will also introduce mosquito noise.

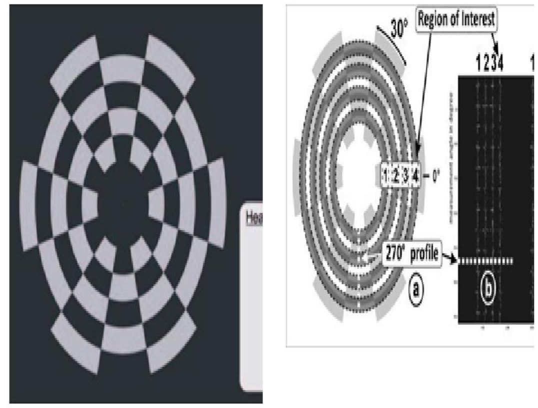


Figure 2: Mosquito noise level measurement

Figure 2. shows the test pattern in (a) and the profile differences in (b).To highlight the mosquito noise artifact in H.264 compressed video sequences. Due to the ripple-characteristic of the ringing art fact, which is the main contributor to mosquito noise, a new test pattern (Dartboard pattern) .The related video sequence, that is composed of different gray values instead of black and white to provide foot room and headroom for undershoots and overshoots.

To achieve better MN measurement results, we filter out the pixel value differences between profiles of consecutive frames of the uncompressed video sequence. These differences originate from the use of a polar profile. Furthermore we apply a threshold to consider only pixel differences that are typical for mosquito noise and do not originate from any other compression artifact.

To assess MN, a rotation-invariant polar re-sampled version of the circular test pattern was used. Computations only incorporate areas of proposed test pattern around edges in the ROI. This approach allows the rotation and shifting of the test pattern through the video as shown in Figure 3.without losing the ability to compare equivalent parts of the test pattern in consecutive frames. To stress the motion compensation algorithm of the encoder, the structure was spun between consecutive frames by one degree and shifted one pixel position in both the x- and y-directions. There by slow varying and fast moving parts in the image, so that global motion estimation can hardly be applied by the codec.

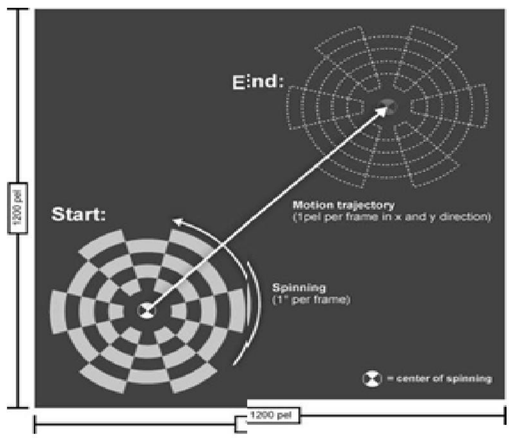


Figure 3: Movement of dartboard pattern in test sequence

If the MC itself produces inaccurate block matches, high pixel differences in the very near area along the image edges can occur. Due to the fact that these MC mismatches had a major influence on the image edge itself and a minor influence on the surrounding pixels, this image distortion does not contribute much to the level of MN in the image sequence.

This approach to measure MN highly differs from the MN mitigation. By reducing the overall ringing level in a video sequence, the MN level will decrease automatically. But due to the fact, that MN is just a subset of ringing; the measurement has to take both the spatial and the temporal aspect of this video artifact into account.

6. MOSQUITO NOISE MEASUREMENT

To assess MN, a rotation-invariant polar re-sampled version of the circular test pattern was used. Computations only incorporate areas of proposed test pattern around edges in the ROI. This approach allows the rotation and shifting of the test pattern through the video without losing the ability to compare equivalent parts of the test pattern in consecutive frames.

Calculate the pixel intensity value difference for each profile of consecutive frames by

$p(\alpha,I)diff = |p(\alpha,I)t-p(\alpha,I)t-1$

Where i=Positions of a pixel value inside a measurement profile,

$p(\alpha,I)t$, $p(\alpha,I)t-1$ are threshold ROIs of conjugate measurement profiles of consecutive frames.

7. ADAPTIVE TV REGULARIZATION METHOD

TV DENOISING

It reduces the total-variation of the image. Filter out noise while preserving edges. Textures and fine-scale details are also removed. In this demo the assumption is that a white Gaussian noise is added. The fidelity term to the input image is calculated automatically so that the power of the noise is reduced.

TEXTURE PRESERVING TV

It reduces selectively the total-variation of the image. Generalization of the TV process to adaptive power constraints. Denoising is strong in smooth regions and weaker in textured regions. Preserves better texture and fine-scale details. This is a two-phase process where the noise and textures are first isolated by scalar TV. The adaptive process then imposes local power constraints based on local variance measures of the first phase.

BLOCKY NOISE

A distortion that appears in compressed video material as abnormally large pixel blocks. Also called "macroblocking," it occurs when the encoder cannot keep up with the allocated bandwidth. It is especially visible with fast motion sequences or quick scene changes. Video uses lossy compression, and the higher the compression rate, the more content is removed. At decompression, the output of certain decoded blocks makes surrounding pixels appear averaged together and look like larger blocks.

8. ALGORITHM

TOTAL VARIATION REGULARIZATION METHOD

DENOISING:

Remove noise from some given image $f:\Omega \rightarrow R^d$,

Assume that

$f = u + n^\delta$,

u is a clean image and n^δ is noise.

Goal:-Reconstruct u from the given data f.

Basic assumptions:

1. Noise characterized by fast oscillations.
2. Image consists of well separated uniform regions.

Assume that the noise satisfies

$\| n^\delta \|_2^2 = \int \Omega \, | n^\delta(X) |^2 dx \approx \delta^2$.

Minimize

$| D_u | (\Omega): \approx \int_\Omega | \ _u(x) | dx$

Subject to the constraint

$\| u-f \|_2^2 = \int_\Omega (u(x)-f(x))^2 dx = \delta^2$.

Choose some final target variation $0<\Theta<1$ and update α until

$r_\eta(v_\alpha/\alpha) \approx \Theta$:

If $var_\eta(v_\alpha/\alpha)(x) < \Theta$:decrease $\alpha(x)$.

If $var_\eta(v_\alpha/\alpha)(x) > \Theta$:increase $\alpha(x)$.

Chosen update:

$\alpha_{new}(x) = \alpha(x).var_\eta(v_\alpha/\alpha)(x) + \Theta/2\Theta$.

For better stability: convolve α_{new} with some smooth kernel ρ.

NONCONSTANT REGULARIZATION METHOD:

Instead of a number $\alpha\epsilon(0,+\infty)$, use a continuous regularization function

$\alpha:\Omega\rightarrow(0,+\infty)$,

and minimize

$T(U;\alpha)=1/2\int_{\Omega}(u(x)-f(x))^2dx+\int_{\Omega}(x)d|DU|$

9.EXPERIMENTAL RESULTS MOSQUITO NOISE

Original Image - Lena

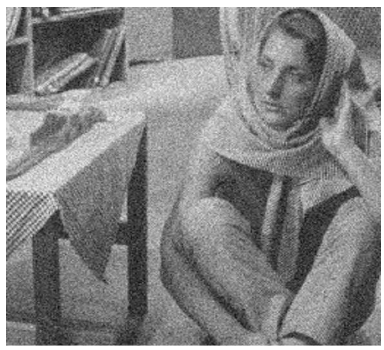
Denoised Image - Lena - Mosquito Noise

Noisy Image - Lena - Mosquito Noise

Figure 4:Orginal image ,noisy image and denoised image by using Lena and barbara (image) for mosquito noise.

Original Image - Barbara

Noisy Image - Barbara - Mosquito Noise

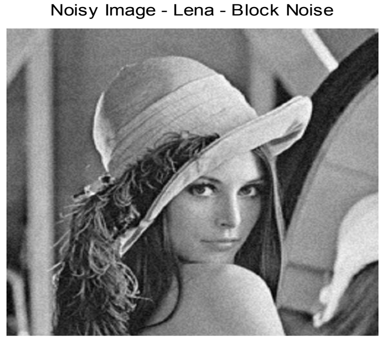


Denoised Image - Barbara - Mosquito Noise

BLOCKY NOISE

Original Image - Lena

Noisy Image - Lena - Block Noise



Denoised Image - Lena - Block Noise

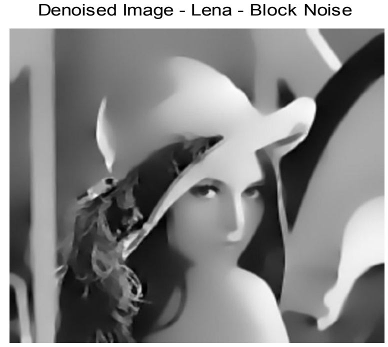
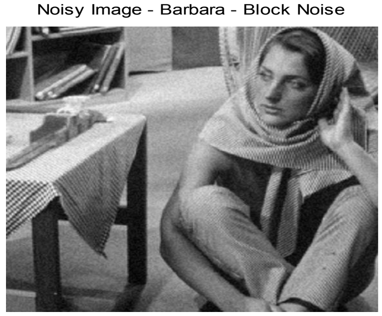


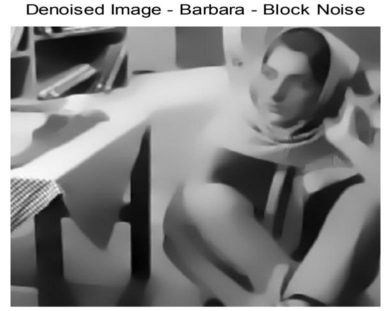
Figure 5:Orginal image ,noisy image and denoised image by using Lena and barbara (image) for block noise.

Original Image - Barbara

Noisy Image - Barbara - Block Noise



Denoised Image - Barbara - Block Noise



TO NOISE:

Figure 4. shows the original image of Lena, noisy image of Lena where the Video compression artifacts include cumulative results of compression of the comprising still images, for instance ringing or other edge busyness in successive still images appear in sequence as a shimmering blur of dots around edges, called mosquito noise, as they resemble mosquitoes swarming around the object. From this figure the De noised image of Lena image that gives the blur image if Lena with the preserving components of mosquito's swarming around the picture.

BLOCKY NOISE:

Figure 5. shows the original image of Lena and noisy image of Lena A distortion that appears in compressed video material as abnormally large pixel blocks.

From the figure, The De noised image of Lena / barbara image is especially visible with fast motion sequences or quick scene changes. video uses lossy compression, and the higher the compression rate, the more content is removed This effect becomes even more pronounced when there's some fast motion or quick camera movement

10.GRAPHICAL REPRESENTATION

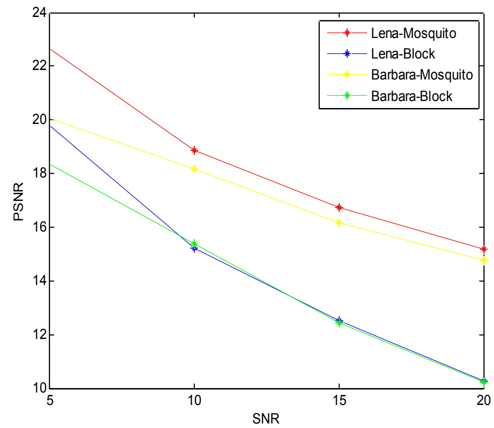


Figure 6: :PSNR Vs Signal to noise ratio for mosquito and blocky noises

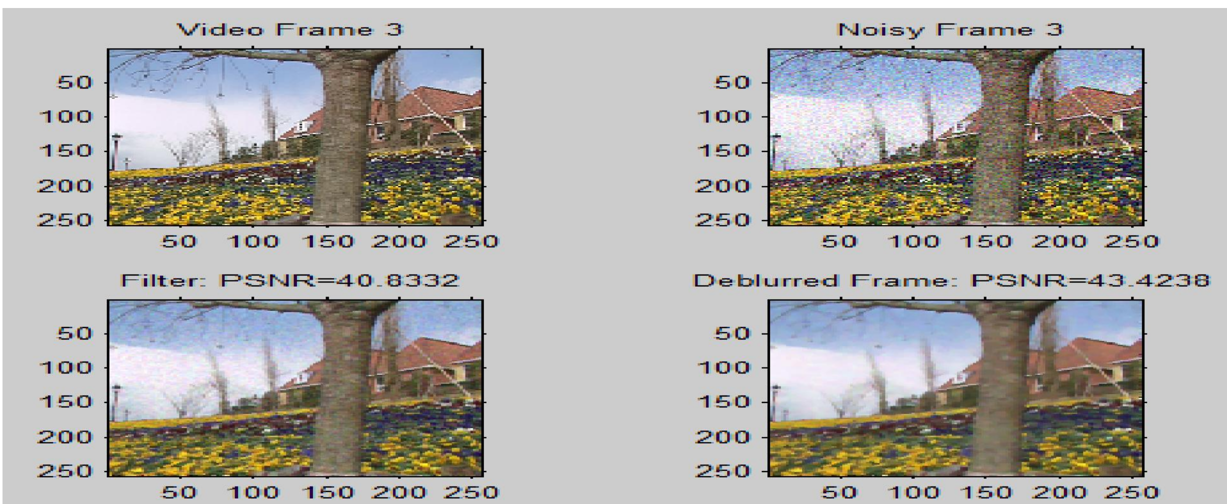


Figure 7.a: VIDEO FRAME b: NOISY FRAME c: FILTER PSNR d: DEBLURRED FRAME

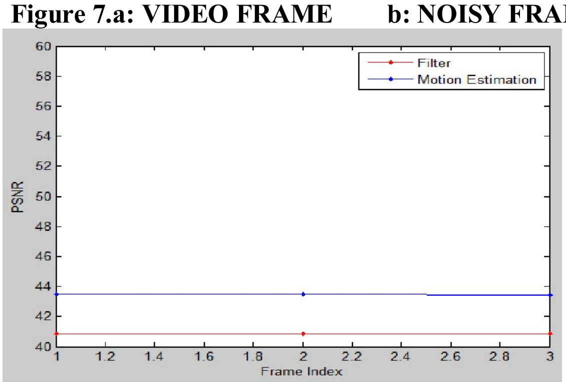


Figure 8: Frame index Vs PSNR

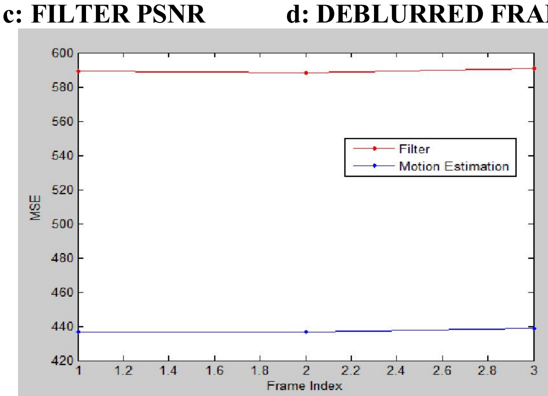


Figure 9: Frame index Vs PSNR

Figure 6.shows the represents the Mosquito noise on x-axis represents noise variance y-axis represents signal to noise ratio.Also the Blocky noise on x-axis represents noise variance y-axis represents signal to noise ratio. Figure 7. shows the represents the Adaptive TV, x-axis represents PSNR on y-axis represents Frame index

The Figure Consists of Four Images

1. Video Frame Image Figure 7. a
2. Video Frame Corrupted by Mosquito Noise and Blocky Noise Figure 7. b
3. Filtering Process Figure 7.c
4. Reconstructed Frame Figure 7.d

Video Frame Image:

The input video sequence is converted into different frames. Each frame will be read one by one and it will be shown in the first plot

Video Frame Corrupted by Noise

The Input video frame is corrupted by different types of noises like mosquito noise and blocky noise.

Filtering Process

The first preprocessing step for this process is the filtering process. The filters consist of Gaussian filter and sobel filter.

Reconstructed Frame

The motion compensation algorithm is used in this part to reconstruct the frame.

Figure 8. shows the represents the Mosquito noise, x-axis represents PSNR on y-axis represents Frame index.

Figure 9. shows the represents the Blocky noise, x-axis represents PSNR on y-axis represents Frame index.

The goal is to improve the visual quality, so perceptual blur and ringing metrics are used in addition to PSNR evaluation and the value will be approx. 43%.(shown in Table.1)The experimental results show much better performances for removing compression artifacts compared with the conventional method.

	PSNR (ADF Method)	PSNR (Filtering Process)	PSNR (Proposed)
Frame Index 1	35.121	40.8577	43.4623
Frame Index 1	35.220	40.8714	43.4603
Frame Index 1	35.650	40.8332	43.4238

Table 1: PSNR Improvement

11.DISCUSSION

PSNR is usually expressed in terms of the logarithmic decibel scale. The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codecs it is used as an approximation to human perception of reconstruction quality, therefore in some cases one reconstruction may appear to be closer to the original than another, even though it has a lower PSNR (a higher PSNR would normally indicate that the reconstruction is of higher quality).

$$MSE=1/mn\ \Sigma\,\Sigma\,[I(i,j)-K(i,j)]^2$$

The PSNR is defined as:

$$PSNR=10.\ \log_{10}(MAX^2_I/MSE)$$

$$20.\ \log10\ (MAX_I/\sqrt{MSE})$$

$$20.\ \log10\ (MAX_I)-10\ \log_{10}(MSE)$$

MEAN SQUARE ERROR:

MSE measures the average of the squares of the "errors." The error is the amount by which the value implied by the estimator differs from the quantity to be estimated.

The MSE of an estimator $\hat{\theta}$ with respect to the estimated parameter θ is defined as:

$$MSE(\hat{\theta})=E[(\hat{\theta}-\theta)^2]$$

The MSE is equal to the sum of the variance and the squared bias of the estimator.

$$MSE\ (\hat{\theta})=Var(\hat{\theta})+[Bias(\hat{\theta},\theta)]^2$$

12. CONCLUSION

We have proposed a new noise removable method for MPEG2 compression artifacts. In the proposed method an image is decomposed into a structure component and texture component by utilizing TV Regularization method. As a result of decomposition compression artifacts are included in texture component. Then mosquito noise is decreased by using Gaussian filter around the edges which are detected from the structure components and motion vectors and blocky noise is decreased by DEF method without losing small texture components which are important for keeping fine picture quality. In the experimental results there was less blocky noise and mosquito noise in the images reconstructed in the proposed method than those of reconstructed using the conventional method and the image quality in the proposed method is much higher than that in conventional method at all bit rates.

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