Block Artifact Reducation in Low Bit Rate Images and Videos

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ABSTRACT
Block artifact is one of the visually annoying problems that usually exist in low-bit-rate compression images and videos. In this paper, we propose a simple but effective method to reduce block artifact based on pixel classification in spatial domain and frequency domain corrupted with impulses, Gaussian noises, artifacts,(Blocking, Ringing, blur,etc..). In traditional methodology, linear filters are not effective in removal of multiplicative noises, impulses noises, and artifacts (Blocking, Ringing, blur,). And also it is large in amplitude; hence it dominates characterizations of the signals based on second-order statistics such as correlation and spectral analysis.
This project aims to design a non linear adaptive based algorithm, smooth region and edge region (low pass filter is performed for image smoothening) by using a binary edge map from the edge detection process, for removing the artifacts (Blocking, Ringing, blurred,) also preserve edges and fine details in images and videos. This algorithm includes detection of corrupted pixels and the estimation of values for replacing the corrupted pixels and adaptive offset smoothing with the binary edge map is applied to reduce grid noise at block boundaries,(Edge detection: edge detection is performed using sobel edge detector.) Moreover extra edge-preserved filters used to remove block artifacts at edge region. And main advantage of the proposed algorithm is the uncorrupted pixels are unaltered and produced in the output. The appropriate filter is used based on the variance of the filter window, for estimating the value for replacing the corrupted value. This leads to reduced artifacts and high fine detail preservation at low bit rate compression image and videos. We have also added the simulation results we got in MAT lab, along with the program.

Index Terms:
Coding artifact reduction Entropy, Blocking artifacts, Adaptive filter.

1. INTRODUCTION

Compression is the process of representing information in a compact form. The goal of any compression technique is to reduce the bit rate for transmission and storage while maintaining the acceptable fidelity or data quality. Due to the increasing traffic caused by multimedia information and digitized form of representation of images and videos, image and video compression have become a necessity. Artifacts are defined as unwanted visible effects in the picture caused by disturbances and errors in the image and video compression and transmission or digital processing. An artifact arises due to inadequate acquisition, inadequate processing, and transmission error.

A compression artifact is the result of an aggressive data compression scheme applied to an image, audio, or video that discards some data that may be too complex to store in the available data-rate, or may have been incorrectly determined by an algorithm to be of little subjective importance, but is in fact objectionable to the user. Artifacts are often a result of the latent errors inherent in lossy data compression. Technically speaking, a compression artifact is a particular class of data error that is usually the consequence of quantization in lossy data compression. Where transform coding is used, they typically assume the form of one of the basic functions of the coder's transform space. Compression artifacts occur in many common media such as DVDs, common computer file formats such as JPEG, MP3, or MPEG files, and Sony's ATRAC compression algorithm.

Nowadays transform-based compression is very popular in the still images and video like JPEG and MPEG. But these compressions are lossy compressions and in addition they are based on the method which divides each image into the blocks. In spite of these defect, usual decoder just perform inverse transform. So there can be some artifacts. Compressed video may possess a number of artifacts, both spatial and temporal. Spatial compression artifacts arise as a result of quantization of the transform-domain coefficients, and are often manifested as blocking and ringing artifacts. Temporal limitations in compressed video occur when the encoder, in an effort to reduce bandwidth, drops frames. The wavelet based compressions produce ringing and blur artifact.

The work presented in this report is related to the detailed study of artifacts that creates major problem in images and video, and try to minimize the noise by using a non linear adaptive based algorithm. Generally noise removal can be achieved by using the linear filtering techniques like low pass; high pass filtering technique, but these filtering techniques introduce blurring effect in the picture. This give rise to the use of non-linear image processing techniques.

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The best-known and most widely used non-linear digital filters based on order statistics are Adaptive median filter.

ALGORITHM IMPLEMENTATION IN IMAGE

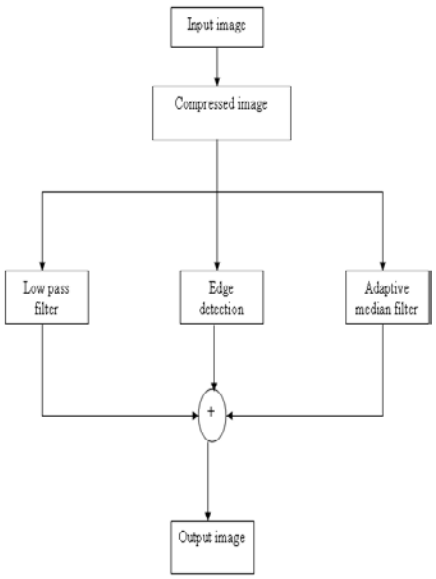


Fig1: Flow chart of the proposed algorithm

WAVELET BASED COMPRESSION:-

Wavelets are functions defined over a finite interval and having an average value of zero. The basic idea of the wavelet transform is to represent any arbitrary function as a superposition of a set of such wavelets or basis functions. These basis functions or baby wavelets are obtained from a single prototype wavelet called the mother wavelet, by dilations or contractions (scaling) and translations (shifts). The Discrete Wavelet Transform of a finite length signal x(n) having N components, for example, is expressed by an N x N matrix.

The wavelet transform is defined as follows. The transformed signal is a function of two variables, t and s , the translation and scale parameters, respectively. t is the transforming function, and it is called the mother wavelet.

The wavelet transform is formally written as:

$$\gamma(s,\tau) = \int f(t)\psi^{*}_{s,\tau}(t)dt$$

Where

*=Denotes complex conjugation.

f (t) =function.

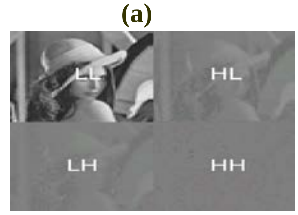
ψ (s,τ)=set of basis function

S=Scale

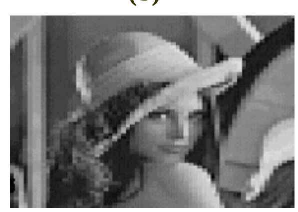
τ=translation.

Despite all the advantages of JPEG compression schemes based on DCT namely simplicity, satisfactory performance, and availability of special purpose hardware for implementation; these are not without their shortcomings. Since the input image needs to be ``blocked," correlation across the block boundaries is not eliminated. This results in noticeable and annoying ``blocking artifacts" particularly at low bit rates. The wavelet transform attempt to solve this problem by using smoothly overlapping blocks. Although blocking effects are reduced in wavelet transform compressed images, increased computational complexity of such algorithms do not justify wide replacement of DCT by WT. Wavelet transform is an efficient approach to reduce spatial redundancies without the annoying blocking artifacts at low bit rates.

(a)



(b)



(c)

Fig: 2 (a) Original image (b)Wavelet Compressed Image (c) Artifact image

Over the past several years, the wavelet transform has gained widespread acceptance in signal processing in general and in image compression research in particular. In many applications wavelet-based schemes (also referred as sub band coding) outperform other coding schemes like the one based on DCT. Since there is no need to block the input image and its basis functions have variable length, wavelet coding schemes at higher compression avoid blocking artifacts. Wavelet-based coding is more robust under transmission and decoding errors, and also facilitates progressive transmission of images. Wavelet coding schemes are especially suitable for applications where scalability and tolerable degradation are important.

The fundamental concept behind Subband Coding (SBC) is to split up the frequency band of a signal (image in our case) and then to code each subband using a coder and bit rate accurately matched to the statistics of the band. SBC has been used extensively first in speech coding and later in image coding because of its inherent advantages namely variable bit assignment among the sub bands as well as coding error confinement within the sub bands.

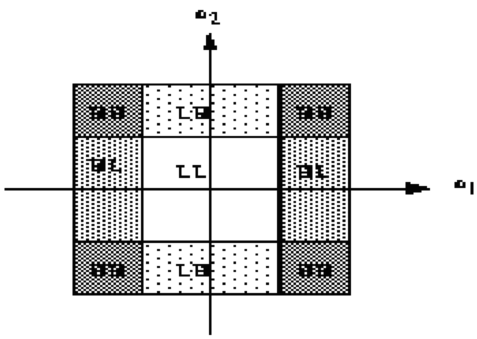


Fig: 3 Subband Coding (SBC)

Over the years, there have been many efforts leading to improved and efficient design of filter banks and subband coding techniques. Since 1990, methods very similar and closely related to subband coding have been proposed by various researchers under the name of Wavelet Coding (WC) using filters specifically designed for this purpose. Such filters must meet additional and often conflicting requirements. These include short impulse response of the analysis filters to preserve the localization of image features as well as to have fast computation, short impulse response of the synthesis filters to prevent spreading of artifacts (ringing around edges) resulting from quantization errors, and linear phase of both types of filters since nonlinear phase introduce unpleasant waveform distortions around edges. The wavelet transform based compression produces the ringing artifacts around edges. My proposed algorithm removes the wavelet based compression artifacts effectively.

ADAPTIVE MEDIAN FILTER:

The Adaptive Median Filter removes the impulse noise from the image and reduces distortion in the image. Adaptive Median Filter can handle the filtering operation of an image corrupted with impulse noise of probability greater than 0.2. This filter also smoothens other types of noise, and gives a much better output image compare than the other filters. Our filter is based on the algorithm described as follows.

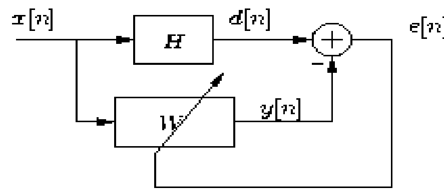


Fig: 4 Adaptive median filters

The adaptive filter works on a rectangular region Sxy. The adaptive median filter changes the size of Sxy during the filtering operation depending on certain criteria as listed below. The output of the filter is a single value which replaces the current pixel value at (x, y), the point on which Sxy is centered at that time.

MATlab Program:

Zmin = Minimum gray level value in Sxy.

Zmax = Maximum gray level value in Sxy

Zmed = Median of gray levels in Sxy

Zxy = gray level at coordinates (x, y)

Smax = Maximum allowed size of Sxy

The adaptive median filter works in two levels denoted Level A and Level B as given follows:

Level A: A1= Zmed - Zmin

A2= Zmed - Zmax

If A1 > 0 AND A2 < 0, Go to level B

Else increase the window size

If window size <= Smax repeat level A

Else output Zxy.

Level B:

B1 = Zxy – Zmin

B2 = Zxy – Zmin

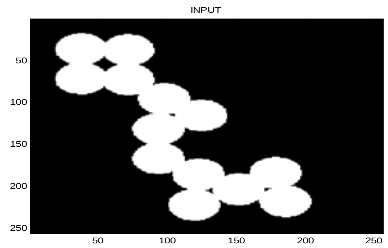
If B1 > 0 and B2 < 0

output Zxy Else output Zmed.

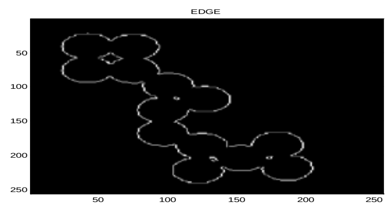
The key to understanding the mechanics of this algorithm is to keep in mind that it has three main purposes:

- To remove salt and pepper (impulse noise) noise, to provide smoothing of other noise that may not be impulsive.
- To reduce distortion such as excessive thinning or thickening of objects boundaries.
- The algorithm to be “impulsive like” noise components, even if these are not the lowest and highest possible pixel value in the image.

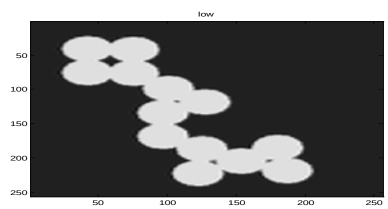
SIMULATION RESULTS



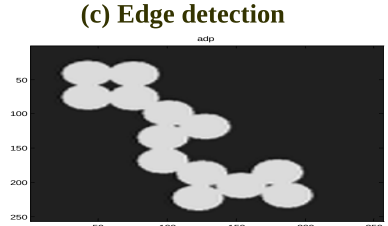
(a)Original image



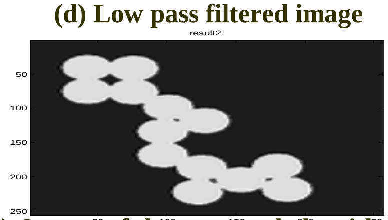
(b) Compressed image



(c) Edge detection



(d) Low pass filtered image



(e) Output of the proposed algorithm

Fig: 5(a) Original image (b) Compressed image (c) Edge detection (d) Low pass filtered image (e) Output of the proposed algorithm

Comparison of proposed algorithm performance with conventional median filter algorithm

TABULATION: 1

ALGORITHM IMPLEMENTATION IN VIDEOS

Video is the technology of electronically capturing, recording, processing, storing, transmitting, and reconstructing a sequence of still images representing scenes in motion. Video technology was first developed for television systems, but has been further developed in many formats to allow for consumer video recording. Video can also be viewed through the Internet as video clips or streaming media clips on computer monitors. The term video commonly referred several storage formats for moving eye pictures: digital video formats, including DVD, QuickTime, and MPEG-4; and analog videotapes, including VHS and Betamax. Video can be recorded and transmitted in various physical media: in magnetic tape when recorded as PAL or NTSC electric signals by video cameras, or in MPEG-4 or DV digital media when recorded by digital cameras. Quality of video essentially depends on the capturing method and storage used. Digital television (DTV) is a relatively recent format with higher quality than earlier television formats and has become a standard for television video. Video can be interlaced or progressive. A video sequence is a three-dimensional array of data in the vertical, horizontal, and temporal dimensions. A video sequence is a collection of frames, with equal dimensions, displayed at fixed time intervals. A video frame is a picture made up of a 2D discrete grid of pixels. The frames can be converted to images for image processing

Image	***MSE***		***PSNR***	
	MF	***AMF***	***MF***	***AMF***
Test. PNG	5.377	1.499	43.523	51.176
Circles. PNG	3.843	1.852	37.943	45.488

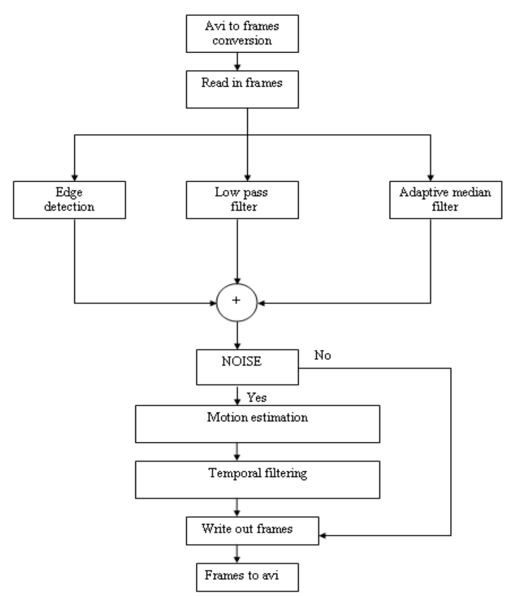


FIG: 6 Flow chart of the proposed algorithm

AlGORITHM:

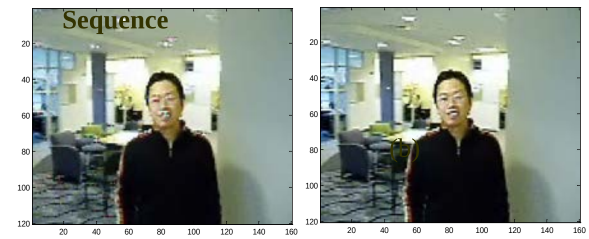
- ***Video to frames:*** The noisy video sequence containing artifact is converted into avi format, which is an uncompressed format and frames are extracted from the video
- ***Frames to images*****:** frames are then converted to images for further processing.
- ***Edge detection:*** edge detection is performed using sobel edge detector.
- ***Low pass filter:*** low pass filter is performed for image smoothening.
- ***Adaptive median filter*****:** Then the output pixel of adaptive median filter is compared and the pixel with a higher quality is used to replace the corrupted pixel.
- ***Motion estimation & motion compensation:*** is performed for all the frames. In motion estimation, motion vectors are determined by considering two consecutive frames. These frames are divided into several macro blocks. A block in the reference frame is compared with that in the current frame and thus motion vectors are obtained. A block matching using Diamond search [15&16] is used for this purpose. Using motion vectors, motion compensation is performed which improves the quality of the picture.
- ***Temporal median filtering:*** median is performed for three frames. They are the original frame, processed frame and the motion compensated frame. This is done to remove the noise further.

- ***Frames to movie*****:** after completing the entire process, the processed frames are finally converted back into original movies

SEQUENCE NAME	MSE		PSNR	
	MF	AMF	MF	AMF
Vipcolor segmentation.avi	21.1045	6.9863	34.9228	39.7360
Vipmen.avi	3.6708	2.5734	42.9369	45.8479

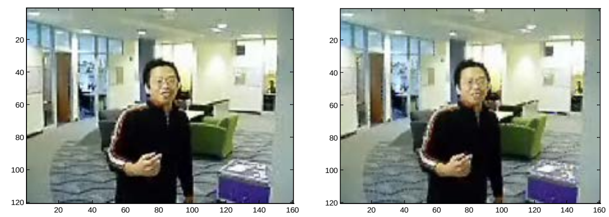
SIMULATION RESULTS:

The video sequence is separated into frames. Each frame is processed by "Adaptive based Algorithm". Then these frames are motion estimated to find the motion vectors. The frames are then motion compensated using these vectors. The motion compensated frames are subjected to temporal filtering to get the output artifact removed frames. Here are sample frames of processed sequences



(a) (b)

Frame no 26 (a) Before processing (b) After processing

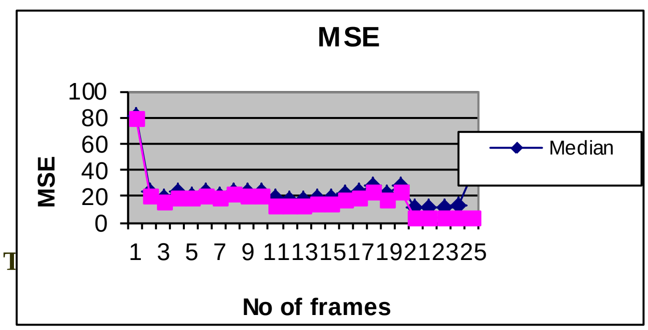


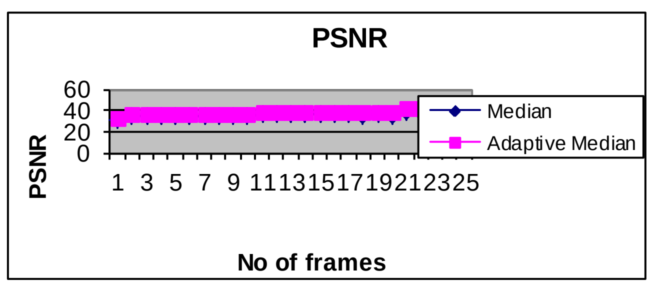
(a) (b)

Frame no 80 (a) Before processing

(a) After processing

Graph: Mean square error for Sequence





Graph: Peak signal to noise ratio for Sequence

TABULATION: 2

CONCLUSION

Image and video processing has become an important task and found usage in many fields. In this thesis, images and video degraded by artifact noises are taken in account and removed using adaptive median filter. The proposed algorithm produces better edge preservation, fine detail preservation and also significantly reduces the artifacts when compared to the median filter. Exhaustive search block matching algorithm produces better PSNR for motion estimation in motion pictures, but in case of large search windows, the computational expenses are large compared to the other motion estimation techniques. The computational expense is less for Diamond search estimation and the MSE and PSNR calculated at compressed video sequence.

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