A Novel Coding using Downsampling Technique in Video Intraframe

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ABSTRACT
Downsampling technique for intraframe coding is a new scenario for low bit rate coding. In the existing methods of downsampling technique, the alternate entire row or column of pixels are downsampling, Which leads to more loss image quality during interpolation. Checkerboard pattern technique is proposed in downsampling process. Here we remove alternate pixel value same as chess board. Interpolation is a process of generating a value of a pixel based on its neighbors. We use adaptive weighted interpolation technique. JPEG-LS technique is to provide effective lossless and near lossless compression in upsampling and downsampling process. LOCO-I algorithm is used in JPEG-LS. By using this technique, the image quality is improved.

General Terms
Downsampling, Interpolation.

Keywords
checkerboard pattern, JPEG-LS, LOCO-I algorithm, low bitrate coding.

1. INTRODUCTION
Compression is used today in many applications, such as broadcast, pay-per-view services over satellite, cable and terrestrial transmission channels, wire-line and wireless real-time conversational services, internet or local area network (LAN) video streaming services, storage formats etc.

An on-line piecewise two-dimensional autoregression algorithm **(**P2A R) is used for modeling and coding of images[1]. The algorithm assumes no stationarity of the source.In Edge-Directed Prediction for Lossless Compression of Natural Images[2] least-square (LS)-based adaptive prediction schemes for lossless compression of natural images was proposed. The most popular lossy image compression method used on the Internet is the JPEG standard. It has good compression performance and low computational and memory complexity.

Downsampling an image to a low resolution[3], then using JPEG at the lower resolution, and subsequently interpolating the result to the original resolution can improve the overall PSNR performance of the compression process. In Adaptive Downsampling to Improve Image Compression at Low Bit Rates [4] new algorithm is proposed in such a paradigm, based on the adaptive decision of appropriate downsampling directions/ratios and quantization steps, in order to achieve higher coding quality with low bit rates with the consideration of local visual significance. JPEG has recently been recognized as the most popular and effective coding scheme for still-frame, continuous-tone images[5]. At a moderate bit rate, JPEG can usually give a quite satisfactory solution to most of practical coding applications. However, the blocking effect produced by JPEG tends to be rather disturbing when a higher compression rate is required. In Adaptive Compressive Sampling for Wideband Signals [6] Adaptive Compressive Sampling (ACS) approach is developed for wideband signals. It doesn't need the sparsity as a priori knowledge. Moreover, it can provide the unoccupied spectrum holes to Secondary Users (SU) in CR for dynamic spectrum access.In low bit Block-Based coders[7], such as the JPEG standard for still image compression and the MPEG-1 and MPEG-2 standards for coding of video sequences, are the most common compression tools used for compression of visual data. Their low computational complexity along with their good performance make them a very attractive choice for many applications. A well-known drawback of block coding schemes is the introduction of visually disturbing blocking artifacts in the reconstructed image. Image interpolation techniques[8] often are required in medical imaging for image generation and processing such as compression or resampling.After JPEG 2000 [9] is used for compressing the image. Since the ideal interpolation function spatially is unlimited, several interpolation kernels of finite size have been introduced.For the fractal image compression [10], genetic algorithm is applied.

In the proposed methodology, compression is done by checkerboard pattern of downsampling technique and decompression is done by adaptive weighted interpolation technique.

The paper is organized as follows. Section 2 present the existing systems in downsampling techniques. Section 3 describes the proposed method which uses checkerboard pattern of downsampling in image compression and adaptive weighted interpolation in decompression of the compressed image. Section 4 discusses the experimental results. Section 5 has conclusion. Finally acknowledgement in section 6.

2. EXISTING SYSTEM

2.1 Down sampling based compression
Coding at low bit rates for video is required for high speed applications such as internet and mobile phone. At low bit rate coding, the quality of picture is degraded due to larger quantization step sizes. It is well known that high spatial correlation exists among neighbouring pixels in a natural image. In fact, most images are obtained via interpolation from sparse pixel data yielded by a single-sensor camera. Therefore, some of the pixels in an image may be omitted (i.e., the image is downsampled) before compression and the follow-on storage/transmission, and at the decoding end they can be restored from the available data using better interpolation/extrapolation methods.

In 1993, B. Zeng and A. N. Venetsanopoulos [5] proposed a method "A JPEG-based interpolative image coding scheme" in which down sampling is first introduced. In that algorithm, the intra frame is down sampled by a 2x2 average operator before JPEG compression and used a replication filter with a 5x5 Gaussian filter to restore the whole image at decompression.

2.2 Down-Scaling For Better Transforms Compression

In 2003, Alfred M. Bruckstein et al. [3] presented a method of down-scaling for better transform compression in which they used the following steps.

1) Deriving the expected compression-decompression mean-square-error for a general image representation. Slicing of the image domain into by blocks is assumed.
2) The coding is done in the transform domain using an orthonormal basis, to derive to error induced due to truncation only.
3) Calculating to account for quantization error of the non-truncated coefficients.
4) Transform the image to the DCT domain.
5) An approximation introduced for the quantization error, as a function of allocated bits.
6) Several possible bit-allocation policies explored and introduce the overall bit-budget as a parameter in the model.

By the introduction of a simple multiscale feature into the JPEG standard in the algorithm, compression ratio is increased. Down-sampling an image to a low resolution, then using JPEG at the lower resolution, and subsequently interpolating the result to the original resolution improved the overall PSNR performance of the compression process. The analytical model and a numerical analysis of the downsampling, compression and up-sampling process, made explicit the possible quality/compression trade-offs.

2.3 An Adaptive Down Sampling To Improve Image Compression At Low Bitrates

In 2006, Weisi Lin and Li Dong [4] proposed a scheme, in which, the downsampling ratio is preset by users.The critical bit rate is low and image dependent, and an encoding process has to be switched between a downsampling scheme and the traditional scheme, in a variable bit-rate (VBR) application for different images, if good coding quality is sought. In low bit-rate coding, whether and how to downsample an image should be determined by the contents of visual signal itself, so that the scarce bits can be used to achieve the best coding quality. The new strategy is proposed to adaptively decide the appropriate downsampling ratio/direction and quantization step for encoding every macroblock in an image, based upon the local visual significance of the signal. If possible, down-sampling should be avoided along the direction of high spatial variations, which signal the existence of edges and other image features with great impact on perceptual visual quality. As expected, this scheme is capable of outperforming the existing down-sampling methods, in terms of coding quality and the critical bit rate. Furthermore, the above mentioned coder switching becomes automatic and adaptive to the actual of the image under processing.

In order to reduce coding and estimation distortion, the adaptive decision on down-sampling and quantization modes (QMs) has taken.

The proposed algorithm follows the framework proposed by Weisi Lin and Li Dong [4]. The steps involved in the method are:

1 Down sample the image using horizontal and vertical coefficients
2. Determine DCT coefficients foreach 8x8 block
3. Quantize the DCT coefficients
4. For a 16x16 macroblock, determine the appropriate down sampling mode (DSM) using downsampling ratios and directions
5. Repeat the steps 1 to 4 according to DSM
6. Apply entropy coding

This algorithm adaptively decides the appropriate down-sampling ratio/direction and quantization step for encoding every macroblock in an image, based upon the local visual significance of the signal. Also it outperforms the standard JPEG method in a much wider scope of bit rates and image quality. The edge detail on either horizontal or vertical direction is preserved and the other direction edge detail would lose due to the decision made on down sampling. The computational complexity of the algorithm is increased due to the additional overheads for representing the DSM and the QM.

2.4 Bilinear Interpolation

Bilinear Interpolation [11] determines the grey level value from the weighted average of the four closest pixels to the specified input coordinates, and assigns that value to the output coordinates. First, two linear interpolations are performed in one direction (horizontally) and then one more linear interpolation is performed in the perpendicular direction (vertically). For one dimension Linear Interpolation, the number of grid points needed to evaluate the interpolation function is two. For Bilinear Interpolation (linear interpolation in two dimensions), the number of grid points needed to evaluate the interpolation function is four.

For linear interpolation, the interpolation kernel is:

$$u(s) = \begin{cases} 0 & |s| > 1 \\ 1 - |s| & |s| < 1 \end{cases} \quad (1)$$

where s is the distance between the point to be interpolated and the grid point being considered.

2.5 Nearest Neighbor Interpolation

Nearest Neighbour Interpolation[11], the simplest method, determines the grey level value from the closest pixel to the specified input coordinates, and assigns that value to the output coordinates. It should be noted that this method does not really interpolate values, it just copies existing values. Since it does not alter values, it is preferred if subtle variations in the grey level values need to be retained.

For one-dimension Nearest Neighbour Interpolation, the number of grid points needed to evaluate the interpolation function is two. For two-dimension Nearest Neighbour Interpolation, the number of grid points needed to evaluate the interpolation function is four.

For nearest neighbour interpolation, the interpolation kernel for each direction is:

$$u(s) = \begin{cases} 0 & |s| > 0.5 \\ 1 & |s| < 0.5 \end{cases} \quad (2)$$

where s is the distance between the point to be interpolated and the grid point being considered.

3. PROPOSED METHOD

3.1 Block Diagram

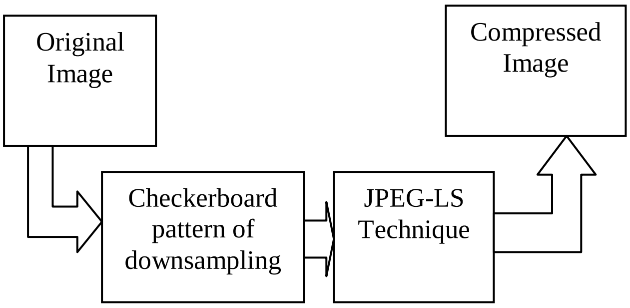

Fig 1(a): Block diagram for compression process

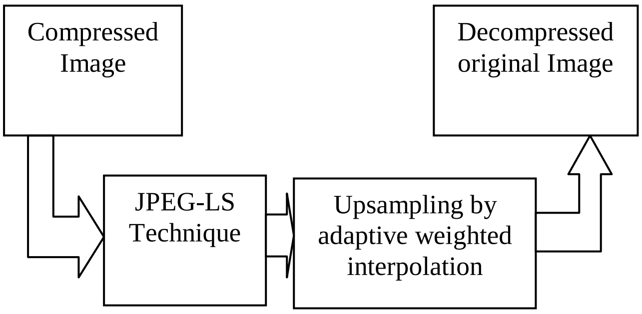

Fig 1(a): Block diagram for decompression process

Fig 1: Block diagram for proposed methodology

3.2 Downsampling In Checkerboard Fashion

Let I be the original (full resolution) color image and ID is a down sampled image based on chess board fashion. For example 8 x 8 image is first level down using chess board gives 8x4 image and the second level downsizing using chess board given 4x4 image

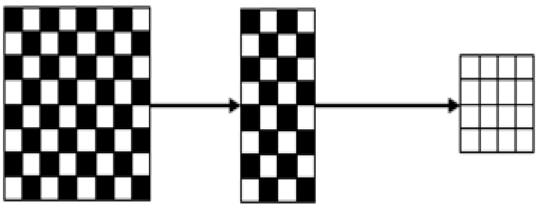

Fig 2: Chessboard pattern

By leaving pixels in the position of black squares and taking only the pixels in the position of white squares in the chess board fashion from the original image is resulted the down sampled image ID.

3.3 Jpeg-LS

JPEG-LS[12] is a recent ISO/ITU-T standard for lossless coding of still images. In addition, it also provides support for "near-lossless" compression. The main goal of JPEG-LS has been to deliver a low complexity solution for lossless image coding with the best possible compression efficiency. It is based on the LOCO-I (low complexity lossless compression for images) algorithm using adaptive prediction, context modeling and Golomb coding. It supports near lossless compression by allowing a fixed maximum sample error.

3.4 Adaptive Weighted Interpolation

In the adaptive weighted interpolation, the gradients are found by finding the differences of the pixel values in both horizontal and vertical position.
The vertical gradient can be found by finding the difference between pixel values A and D.
The horizontal gradient can be found by finding the difference between pixel values B and C such that

Vertical gradient V = (A-D)
Horizontal gradient H = (B-C)

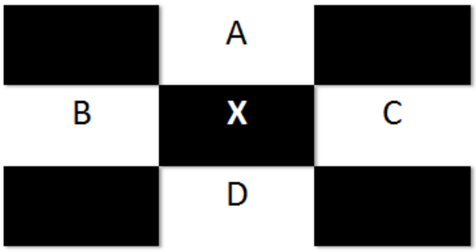

Fig 3: Adaptive weighted interpolation pattern

The threshold can be fixed such that its value should be greater than the sum of vertical and horizontal gradient.
Then the value of X can be calculated such that

$$X = (A+B+C+D)/4 \qquad (3)$$

We add the weighted coefficients to the pixel values in some cases. If the horizontal gradient is greater than the threshold value, we add the weighted coefficients such that the values of horizontal pixels should be greater than the values of vertical pixels. It is denoted as

$$X = (W1B+W1C+W2A+W2D)/4 \quad \text{for } W1>W2 \quad (4)$$

If the vertical gradient is greater than the threshold value, we add the weighted coefficients such that the values of vertical pixels should be greater than the values of horizontal pixels. It is denoted as

$$X = (W1B+W1C+W2A+W2D)/4 \quad \text{for } W2>W1 \quad (5)$$

By this adaptive weighted interpolation, the quality of the decompressed image is improved.

4. EXPERIMENTAL RESULTS

The metrics used for the performance evaluation (ie to measure the quality and efficiency) are: CompressionRatio (CR), Mean Square Error (MSE) , Peak Signal to Noise Ratio (PSNR) and Bit Rate

4.1 Compression Ratio

The Compression Ratio of the compressed Intraframe J from the original Intraframe I is defined by Equation 6

$$CR = \frac{I_s}{J_s} \qquad (6)$$

where I_s is the size (in terms of bits) of the uncompressed Intraframe I, and J_s is the size of the compressed Intraframe J. The value of CR will be always greater than 1.

4.2 Mean Square Error

MSE of the decoded intraframe defines the amount by which the decoded intraframe differs from the original intraframe. The value of MSE will be greater than or equal to 0. The MSE of the decoded intraframe, I' from original intraframe, I is defined in Equation 7

$$MSE = \frac{1}{m*n}\left(\sum_{i=0}^{m-1} \sum_{i=0}^{n-1} \left(I_{i,j} - I'_{i,j}\right)^2\right) \qquad (7)$$

Where $m \times n$ is the size of the Intraframe

4.3 Peak Signal-To-Noise Ratio

The Peak Signal-to-Noise Ratio (PSNR) is an important metric to measure the objective dissimilarity of the decoded intraframe from the original Intraframe. Because many signals have a very wide dynamic range, PSNR is expressed in terms of the logarithmic decibel scale. It can be defined using MSE in Equation 8

$$PSNR = 10\log_{10}\left(\frac{255^2}{MSE}\right)dB \qquad (8)$$

where 255 is the maximum pixel (signal) value of the Intraframe (when B bits are used to represent a pixel, then this maximum value will be $2^B - 1$) with a pixel represented by 8 bits. For color images with three RGB levels, the PSNR is the same except that the MSE is the sum over all the squared value differences divided by image size and by three.

4.4 Bit Rate (Bits Per Pixel)

Bit rate is an average bits required to represent a single sample (pixel) in the compressed Intraframe. The standard Intraframe the bit rate of the Intraframe is 8 bits per pixel (bpp). The bit rate is defined as

$$\text{BitRate} = \frac{J_s}{I_n} \qquad (9)$$

where J_s is the size (in terms of bits) of compressed file and
I_n is the total number of pixels present in the given Intraframe.
The value of bitrate will lie in between 0 and 8.

Fig 4: Compression of the image by checkerboard pattern (a) Original image (peppers) (b) compressed image at level 1 downsampling (c) compressed image at level 2 down sampling.

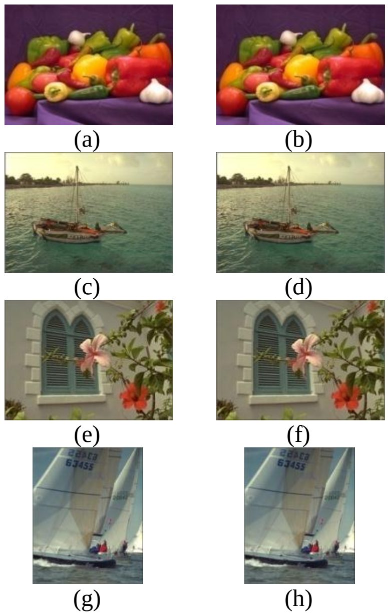

Fig 5: Experimental intraframe input and output images (a)Peppers(original) (b)Peppers (reconstructed) (c)kodim06-sea (original) (d)kodim06-sea (reconstructed) (e)kodim07-flower (original) (f)kodim07-flower(reconstructed) (g)kodim10boat(original) (h) kodim10-boat (reconstructed)

	Compressed image				Decompressed image	
	CR	Bit rate	MSE	PSNR	MSE	PSNR
Pepper	15.83	0.063	153.14	20.78	5.65	40.83
Kodim06 (sea)	12.98	0.118	198.28	29.68	7.83	42.93
Kodim07 (flower)	16.14	0.099	225.67	24.14	6.29	37.72
Kodim10 (boat)	17.68	0.45	176.20	25.67	8.27	44.65

Table 1: Experimental results for input and output images

The decompressed image is obtained by adaptive weighted interpolation method and the PSNR value is comparatively large which results in better image quality.

For compressed image,Compression Ratio = 15.653
For compressed image, Bit rate = 0.1825
For decompressed image, Mean Square error = 7.1
For decompressed image, Peak Signal to Noise Ratio = 41.529

5. CONCLUSION

Compression of the image by downsampling pattern can reduce the coding and estimation distortion. Since the JPEG-LS technique introduced in the proposed system, the loss of pixels during image recovery is reduced.

The checkerboard pattern of downsampling is more advantageous than other downsampling techniques because the checkerboard pattern removes the alternate pixels in both row and column of the image in compression while the other techniques remove the pixels of the entire alternating rows or columns of the image. So this technique improves the image quality while decompression. The adaptive weighted interpolation technique used in decompression of the image helps for edge preservation and minimum loss of pixels in the image.

The proposed method achieves high PSNR value with less MSE at good compression ratio. It reduces computational complexity and the edges are preserved which results in better image quality.

6. ACKNOWLEDGEMENT

We would like to thank Dr. C.Seldev Christopher, Professor, St. Xavier's Catholic College of Engineering for his constant encouragement and support.

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