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SINGLE PIXEL DEPENDENT PREDICTION WITH DOWNSAMPLING AND INTERPOLATION

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Abstract— In the past decades, video coding technologies have greatly promoted the development of digital multimedia contents related industry. To satisfy the rapid increasing demand for high-definition (HD) and ultra-HD (UHD) video contents, a higher requirement for more efficient video coding has been brought forward. In this paper we propose a new approach for efficient video compression. We mainly focus on intraframe coding that performs compression techniques on any one of the frames in video sequence. A single pixel based lossless prediction (SPLP) along with downsampling and interpolation is used to achieve a better compression ratio compared to existing system. SPLP is an enhancement of H.264/MPEG-4 standard, which employs pulse code modulation for better prediction. Along with SPLP, a checker board pattern downsampling and adaptive weighted interpolation techniques are used to improve the performance.

Keywords— SPLP, Checkerboard downsampling, adaptive weighted downsampling, Differential pulse code modulation, H.264, Bilinear Interpolation, MDDI.

1. INTRODUCTION

Video compression reduces or removes redundant data so that a video file can be effectively transmitted and stored. The process of video compression involves the application of an efficient algorithm to the source video to create a compressed file that is ready for transmission and storage. Various video coding standards are available. Most popular compression standards are JPEG, motion JPEG, H.261, H.263, MPEG, H.264 etc.

Our existing system, mode dependent downsampling and interpolation (MDDI) [1] method divides the pixels in a given image into two sub-images namely even row wise pixel image and odd row wise pixel image using a uniform downsampling[2],[3] method. For the odd downsampled pixel image, bilinear interpolation [4] is applied to predict other even sampled pixels. Then we applies H.264 intra prediction [5],[6],[7] into the odd pixels to develop an adaptive downsampling structure. Then residual of both the odd wise sampled and even wise sampled pixels are calculated and encoding is applied on both residual. On the odd row wise sampled image H.264 intra prediction is applied, where coding performance is based on the rate-distortion (RD) measurement.

There are some limitations in our existing system and they are:

- The Prediction Mode Selection complexity is more.
- Bit rate ratio can be improved further in most of the cases.
- The Hardware complexity is more in most of the algorithms which can be lessened.
- The time complexity can be reduced further.
- Edge details can't be preserved.
- Can improve residual quality further

To overcome all this drawbacks we go for a new method named single pixel dependent lossless prediction (SPLP) along with checkerboard downsampling and adaptive weighted interpolation.

2. PROPOSED METHOD

We propose three changes for our existing system to improve the intra frame coding. First we replace uniform downsampling with checkerboard pattern downsampling [8] in order to preserve the edge details. Then an adaptive weighted interpolation [9] can be taken instead of bilinear interpolation so that we can improve the residual quality and thereby can improve the compression rate. Then we are giving a proposal of replacing H.264 with SPLP [10] which will further improve the compression rate. The block diagram for the proposed method is given in Fig.1

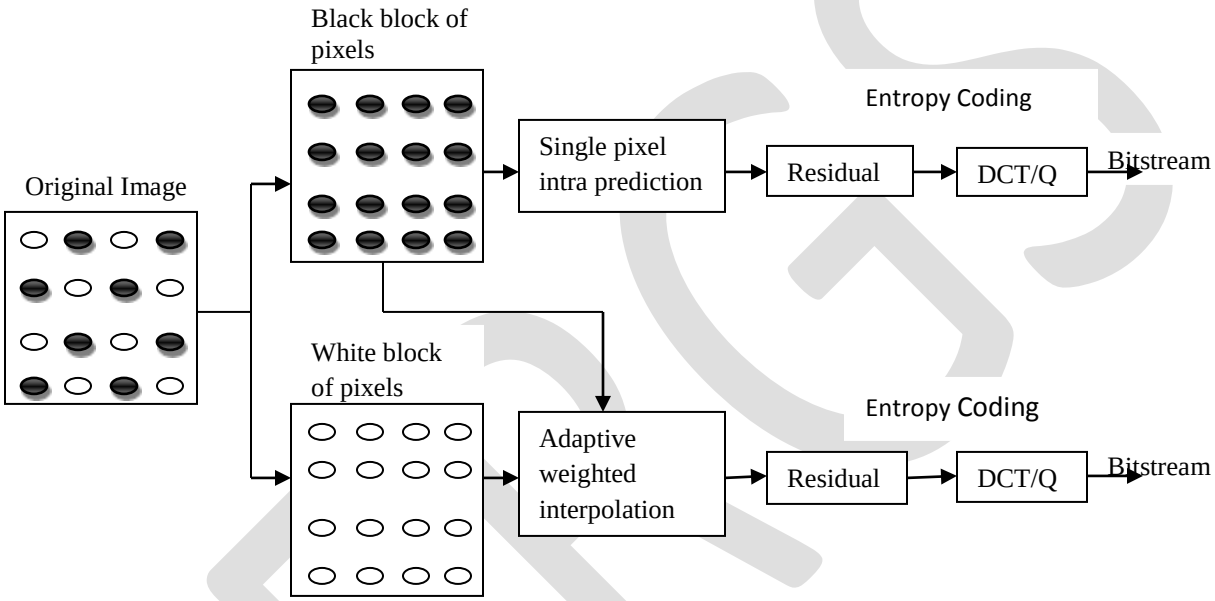

Fig.1: Block diagram for proposed method

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 images are first level downsized using chess board pattern gives 8x4 image and the second level downsizing using chess board given 4x4 image. We would get 2 blocks namely black block of pixel and white block of pixel.

Adaptive weighted interpolation would be applied to black block of pixels. 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 as shown in Fig.2. 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)

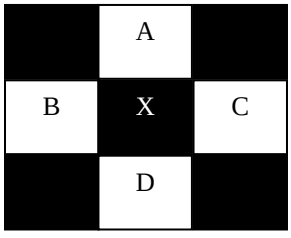

Fig.2: Adaptive weighted interpolation pattern

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

$$X = \frac{(A + B + C + D)}{4}$$

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

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

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

$$X = \frac{W1A+W1D+W2B+W2C}{4} \quad \text{for W2>W1}$$

After applying adaptive weighted interpolation method we can calculate the residual by subtracting the result from white block of pixels. Then need to do discrete cosine transformation and quantization on the residual to achieve better compression.

SPLP is a new source pixel based prediction technique for lossless intra coding technique which is applied again to the black block of pixels. It employs DPCM (Differential Pulse Code Modulation)[11],[12] and it is developed as an enhancement of intra frame coding of H.264/MPEG-4 AVC standard. Identification of a source block adaptively among the sixteen micro blocks of a macro block in 4:4:4 format is based on visual perceptual considerations for both luma and chromo components. From the selected source block, SPLC selects a source pixel adaptively within the block. Using the selected source pixel SPLP predicts other pixels in the selected source block and then predicts all pixels in the remaining fifteen micro blocks in a macro block using this source block.

The prediction is carried out using DPCM. The philosophy of predictive techniques is to remove inter pixel redundancy between successive pixels. In order to reduce the time complexity in mode selection, the residual of predicted pixel is calculated by using only the two directional modes 1 and 2 of DPCM rather than all of its nine modes. Finally, the residuals are encoded with the arithmetic entropy coder.

Advantages of proposed system:

- Reducing the time complexity during the Prediction Mode Selection phase of the lossless Intraframe coding algorithms was identified as one of the pressing needs in lossless Intraframe video compressions techniques.
- Proposed prediction technique which keeps one pixel as source to predict the entire pixels in the source micro block of a given macro block. The source micro block will be subsequently used for predicting the other micro blocks in the macro block, which can make efficient block wise compression.
- Proposed system could improve the compression ratio substantially. These algorithms work on a new pixel based prediction technique to predict the pixel, increasing the data redundancy leading to much improved compression ratio and use Differential Pulse Code Modulation for prediction.
- The pixel based algorithms SPLP can achieve a substantial reduction in the hardware complexity in preprocessing by reducing the number of modes to just two to predict the pixels in the macro block in comparison with the other algorithms which use between 4 modes and 9 modes.
- Edge details could be preserved by applying adaptive checkerboard pattern downsampling.
- Adaptive weighted interpolation helps in improving the residual quality and thereby improving the compression rate.

3. CONCLUSION

In this paper, an improved prediction method along with two efficient techniques is proposed for better compression of videos. The techniques we preferred here are single pixel based intra prediction (SPLP), an adaptive weighted interpolation and a checker board downsampling method. The use of SPLP technique reduces the time complexity and coding complexity. The proposed techniques preserve the edge details and improve the residual quality. So we could achieve a significant performance improvement with the decrease in complexity.

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