Mhp Lossless Image Compression Coding Scheme for and Efficient Compressed Image Transmission Through Wireless Networks

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Abstract *- In the modern world of gadget's era huge of volume data is generated in the forms of multimedia data. Generated data in the form of images need more space for storage and takes more bandwidth while transmitted across the networks. With help of Image compression methods the image size can be reduced. With reduction of image size with compression process helps to transmit the image across the networks in a faster manner with lesser bandwidth. In this work, a novel image compression method is proposed using Modified Hierarchal Predication (MHP) color image coding scheme. Once compression is done it passed through the various wireless notebooks such as WLAN, WiMax and Wi-Fi to verify the effectiveness of the compression. Proposed work MHP gives much better result than the existing approach.*

Keywords*: Modified and Block based Hierarchical Prediction, Wireless Network, WLAN, WiMax, Wi-Fi*

I. INTRODUCTION

A digital image in modern era needs more storage and processing spacing as well as need bandwidth while transmitting across the networks. Image compression is one of the solutions for these problems. Though there are so many image compression are proposed by researchers, still there is hope for reducing the computational complexity of the processing algorithm as well as reducing size further with novel research work. In the process of image compression, the image quality has to be retained as close as to the original image with reduced bit rate of the image.

Basically Image compression process is of two types namely, lossy compression and lossless compression [1]. Lossless compression technique is method where complete information is retained as original information after compression and decompression process. Lossless compression is mostly favored techniques in the areas such as Medical images, Satellite images, scientific images etc where every bit of information is important. A major amount of information is vanished in the compression process with Lossy compression technique.

To retain the complete information and sharpness of image after encoding and decoding the lossless compression techniques are used in this modern era even in a normal image. There are lots of Lossless compression technique have been proposed by researcher in the past few decades. JPEG-LS coder is mostly used technique in lossless and near lossless image compression process [2]. Color transformation method is applied on the color image to avoid the eminent correlation caused due to the occurrence of the similar information in more than one image channel [3]. Most of the exiting method of prediction is depends on the raster scan predication which is unproductive at the high frequency area. To handle this issue Seyun Kim et al introduced Hierarchical Prediction scheme which performs the operation edge directed prediction and compression using context adaptive model (HPCA) [4].

In HPCA, image compression, the image is separated into odd image and even image. After separation of image, even image is encoded and then it is used to predict the odd image pixel values. To predict pixel either horizontal or vertical predictor is used depending upon the difference between the original values and predicted values. Vertical predictor predicted value will be used when it is less than the than horizontal predictor value, otherwise horizontal predictor is used. This HPCA technique decreases the bit rates than JPEG2000 and JPEG-XR schemes. In this approach high prediction error rate occurs near edges due to cause of performance degradation. Because of these errors the sharpness of the images gets pretentious. It is important to preserve the sharpness of the image in the compression process. For protecting the sharpness of the image and minimizing bitrates, a new method is necessary.

In this novel work, a diagonal predictor is introduced for predicting the diagonal in the chrominance channel C_v and C_u to amplify the prediction accurateness. It is named as Modified Hierarchical Prediction (MHP) coding scheme. Proposed work MHP achieve high compression ratio than the existing approach. But upholding the image quality during network broadcasting is also extremely significant. It can be verified with transmitting images across context Conscious network scheme such as UMTS, WiMax, Wi-Fi. With context Conscious network, images can be broadcasted with effectiveness of the platform in the context of both the data compression with a suitable quality degradation and good data transmission over the wireless environment.

The paper is organized with brief related researches in Section II, where as Section III deals with methodologies used in the paper. Section IV presents the results and discussions. Conclusion is given the Section V.

II. RELATED WORKS

Aguilera [5] presented a color space for arithmetical representation of a set of colors. The top most colors are Red, Green and Blue (RGB) which is utilized in computer graphics. All color spaces can be resultant from the RGB information applied by devices such as cameras. In the case of lossless compression, many color transforms could not be applied owing to their non-invariability through integer arithmetic. The invertible color transforms and reversible color transform are exploited by JPEG 2000.The hierarchical prediction is developed for predicting the pixels instead of raster scan prediction method.

Lin *et al.* [6] proposed an efficient lossless image compression scheme using two stage predictors. In the first stage predictor, the spatial data correlations are considered and the derivation of the spectral domain predictor as a process of Wiener filtering is performed. Similarly in second stage predictor, the prediction output in the first stage is used as initial value and incorporates a Backward Pixel Search (BPS) scheme on the current band for the final prediction value. Thus the coding of the hyper spectral images is efficient and free of lookup table memory. The drawback of this approach is that in images where the calibration-induced artifacts are minimized, better prediction addition is achieved with the first stage predictor itself which makes the second predictor unnecessary.

Doukas *et al.* [7] proposed a novel platform for the effective and adaptive transmission of the medical images using scalable coding and context Conscious wireless medical networks. The images initially use the adaptive and scalable coding to enable seamless and dynamic adaptation of the content according to the network status. The wavelet based scalable image compression along with the Region of Interest (ROI) coding support is utilized for the adaptive transmission through the medical networks with less image quality degradation.

Martini *et al.* [8] presented a flexible macro-block ordering for the context aware ultrasound video transmission over the mobile networks. The approach focuses on providing the context aware design of the video signal transmission over the WiMAX systems. The medical status is taken as context and ROI as per the sessions. Then an error-resilient transmission of ultrasound scheme is utilized to reduce the errors in the transmission.

III. METHODOLOGIES

A. *Modified Hierarchical Prediction (MHP)*

Seyun Kim et al [4] proposed a lossless color image compression algorithm called the Hierarchical Prediction and Context-adaptive Arithmetic coding. In this work, the color image is converted into YC_uC_v color space from RGB color space. While color transformation of YUV color space, the gets decomposed into to chrominance and luminance channel. Traditional lossless compression technique is applied on luminance channel. Upper, left, and lower pixel prediction predictor are used on chrominance channels C_u and C_v for decomposing and encoding. Arithmetic coding is applied for encoding the error signal of each context which is given by the context model. Sharpness of original image is not good in this work because of high prediction error rate near edges.

To maintain the good sharpness of image and decrease the bit rates, a novel scheme is proposed called Modified Hierarchical Prediction (MHP) for chrominance channel. In this work, along with existing vertical and horizontal predictors, new diagonal predictor (left up, left down and right up, right down pixels) is introduced for getting accuracy in pixel prediction. At the beginning stage, chrominance image is divided row by row into even subimages and odd subimages.

For every pixel a_o(x, y) in a_o diagonal a_d (x, y) is described as follows and one of them is chosen as a predictor for a_o(x,y).

$$\widehat{a_h}(x, y) = a_o(x, y-1)$$

$$\widehat{a_v}(x, y) = \left(\frac{a_e(i,j)+a_e(x+1,y)}{2}\right)$$

$$\widehat{a_d}(x, y) = \left(\frac{a_e(x+1,y-1)+a_e(x-1,y-1)+a_e(x-1,y+1)}{2}\right)$$

Predicated Image is determined with horizontal, vertical and diagonal pixels. With diagonal predictor it is possible to predict the correct predicted image. Further image is divided into even subimage and odd subimage from even subimage in column by column basis. Even subimage $a_e^{(2)}$ is produced from compressed $a_o^{(2)}$ Odd subimage. With diagonal predication, sharpness and quality of the image is preserved. It is achieved with Modified Hierarchical Prediction (MHP).

B. *Transmission of images across Context Conscious Wireless Networks*

MHP Lossless Image Compression (MHPLIC) scheme is used encode and compress the images. After the compression process of the images it is broadcasted to the destination. In order to offer effectual transmission, the adaptive compression scheme is used for different wireless networks. WLAN, Wi-Fi and WiMax are the wireless network used for transmission. While comparing with various networks, WLAN, Wi-Fi and WiMax are considered to be efficient network environment for data transmission process [9].

The adaptive compression points to the efficiency of the stage in the context of both the data compression with acceptable quality degradation [4] and proper data transmission over the wireless network. Thus the images can be proficiently encoded, compressed and efficiently transmitted over the wireless networks. In this work, the encoding scheme proposed in the first phase work of this research is used for this purpose. The scheme MHPLIC is applied for effectual encoding.

In modern network era, users are located in remote locations which need an infrastructure for data transmission. With conventional network transmission procedure image data transmission cannot be completed in a successful and proficient manner. Various problems like huge data size, unwanted data transmission, limited network resources can lead to unproductive usage of network system. To prevail over the problem, suitable content coding technique called Context Conscious scheme is proposed.

1) *Working of Context Conscious Scheme*

This novel scheme is designed to allow image transmissions only when necessary, and to encode the transmitted data properly according to the network accessibility and user choices. Context conscious refers to the ability of systems to act in response based on their surroundings. Through the context-conscious framework, image delivery can be optimized in terms of improved resources use and finest apparent class.

The proposed approach centers on providing loss protection to the images transmitted over the wireless networks. As the networks WLAN, WiMAX and Wi-Fi are faster, there should be less number of packet losses. The compression scheme is presented with system for avoiding losses. The QoS parameters such as bit error rate and packet loss are considered in the selection of wireless networks.

2) *Simulation of Networks*

To carry out the variety of wireless network transmissions, a replicated environment of WLAN, Wi-Fi and WiMax is created using the MATLAB computational tool. MATLAB offers some predefined blocks [10] such as data, randomizer, encoder and transmitter which are used in the image encoding and transmission process for transmitting image across the networks.

Simulated models are used to transmit the proposed scheme's compressed images over various channels. Various parameters used to analyze the process are Bit Error Rate (BER), Packet loss and Packet Delay to find the best suitable network environment for image transmission over wireless networks.

The procedure followed in the transmission of images is that the compression schemes HPCA and MHPLIC are initialized. Then the context conscious network scheme is applied for effectual transmission. The compressed images are transmitted over the chosen network and received at the receiver.

IV. Experimental Result

Effectiveness measuring parameters such as Compression Ratio and Peak Signal to Noise Ratio (PSNR) are used to evaluate the HPCA and MHPLIC scheme. The existing HPCA and proposed MHPLIC Scheme are evaluated with above mentioned performance metrics. From the Experimental result, it can be conclude that proposed MPHLIC method preserve the sharpness of particular image better than HPCA. Hence proposed Modified Hierarchical Prediction Lossless Image Compression Scheme is better in conserve the sharpness of image and reduce the quality degradation.

Compression Ratio:

Compression ratio is described as the ratio of an original image and compressed image.

$$Compression\ Ratio = \frac{Original\ \ Image\ \ size}{Compressed\ \ Image\ \ Size}$$

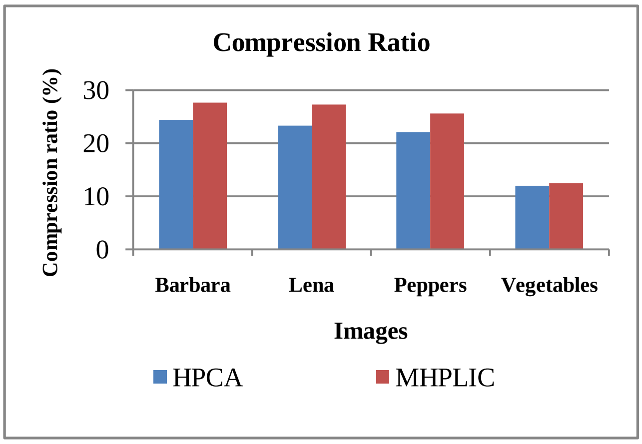


Figure 1 demonstrates the assessment of the proposed MHPLIC scheme and the HPCA scheme in terms of compression ratio.

Fig. 1 Compression Ratio (CR)

Above graph shows that proposed method provides better result than the existing approach with increase of compression ratio. From the experimental result we can conclude that MHPLIC is better than HPCA. The comparison of MHPLIC and HPCA is shown in Table 1.

Table.1. Compression Ratio (%)

Images	HOCA	MHPLIC
Barbara	24.29	27.59
Lena	23.26	27.19
Peppers	22	25.5
Vegetables	11.9	12.46

Peak Signal to Noise Ratio (PSNR)

Peak Signal to Noise Ratio defines the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation.

The PSNR (in dB) is defined as:

$$PSNR = 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

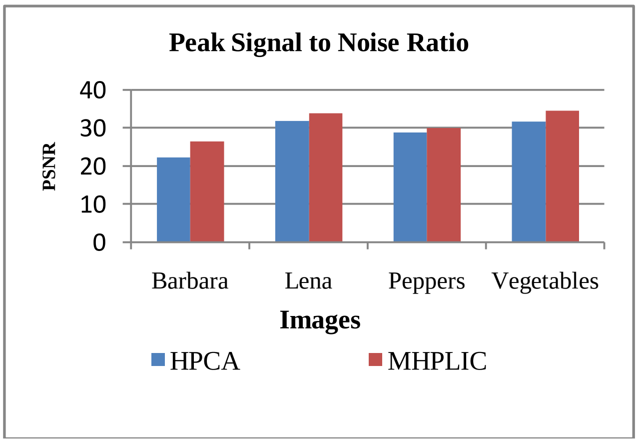


Fig. 2 Peak Signal to Noise Ratio (PSNR)

Figure 2 illustrates the comparison of the MHPLIC and HPCA in terms of PSNR. The PSNR value is significantly reduced with MHPCA when compared with HPCA. Thus, result shows that MHPLIC method is better than HPCA in terms of PSNR value.

Table 2 PSNR values

Images	HPCA	MHPLIC
Barbara	22.43	26.57
Lena	31.91	33.87
Peppers	28.91	30.16
Vegetables	31.79	34.56

Table 2 provides comparison of HPCA and MHPCA coding schemes in terms of PSNR. From the table values, it is clear that the MHPCA scheme yields better PSNR values when compared to the HPCA coding scheme.

Second phase of the work is evaluated using Bit Error Rate and Packet Loss. The comparison results are shows in graphs and tables formats.

Bit Error Rate

Bit Error Rate (BER) is the number of bit errors per unit time. It is calculated as the number of bit errors divided by the total number of transferred bits during a studied time interval. The BER for different wireless networks are shown in Table III.

Table 3 Bit Error Rate

Methods	WLAN	Wi_Fi	WiMAX
HPCA	0.0021	6.51E-04	8.14E-05
MHPCA	0.0024	6.51E-04	8.14E-05

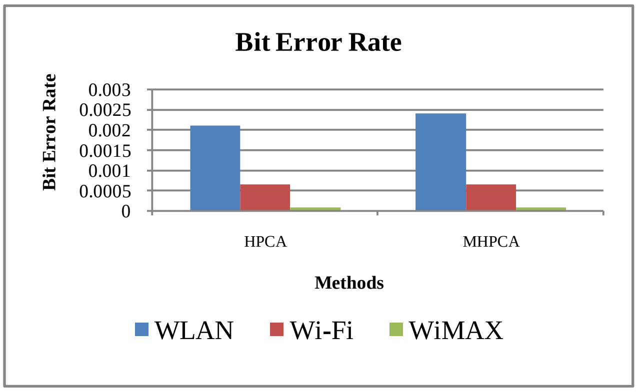


Figure 3 shows the comparison of Bit Error Rate (BER) of compression schemes through different wireless networks.

Fig. 3 Bit Error Rate (BER)

Packet Loss

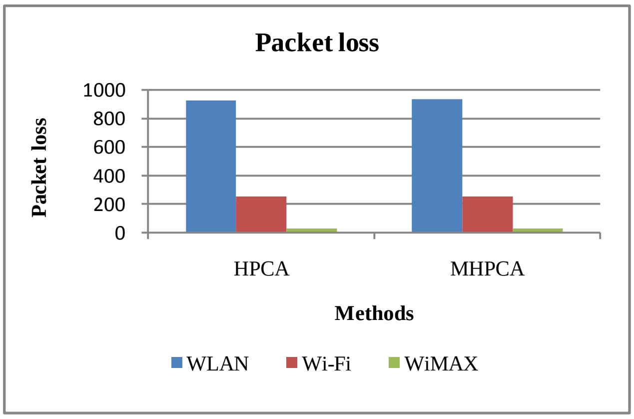
Packet loss is calculated as the number of packets lost with respect to packets sent. Packet loss occurs when one or more packets of data transmitted in a network that fail to reach the desired destination due to factors like network congestion, etc.

Table 4 Packet Loss

Methods	WLAN	Wi_Fi	WiMAX
HPCA	923	256	32
MHPCA	933	256	32

The packet loss rates for different wireless networks are shown in Table 4.

Figure 4 shows the comparison of the packet loss of compression schemes through different wireless networks. Barbara image is considered for transmission through the



wireless networks. From the graph, it is clear that the WiMAX network provides effective image transmission with reduced packet loss.

Fig. 4 Packet Loss

V. Conclusion

A novel MHPLIC method is proposed in this paper. The proposed MHPLIC method preserves the sharpness of the image and achieves the high compression ratio when compared with existing HPCA approach. Also the proposed algorithm gives high PSNR value. It is concluded that MHPLIC is better method. In second phase of the work, image is transmitted across the various wireless network environments. The wireless networks WLAN, Wi-Fi and WiMAX are considered for image transmission. From the results, it is proven than Bit Error Rate and Packet loss is much lesser for WiMAX when compared with WLAN and Wi-Fi. Conclusion of second phase work is WiMAX network offers better image transmission with proper transmission and with acceptable image quality degradation.

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