OPTIMIZATION FOR SCALABLE VIDEO MULTICAST IN WIRELESS NETWORKS

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ABSTRACT: -

The demand for access to advanced, distributed media resources is nowadays omnipresent due to the availability of Internet connectivity almost anywhere and anytime, and of a variety of different devices. The advancement in wideband wireless network supports real time services. Scalable video coding (SVC) with adaptive modulation and coding (AMC) provides an excellent solution for wireless video streaming. Multicast uses the lowest modulation resulting in a video with only base quality even for users with good channel conditions. For optimal resource allocation, a key issue in applying SVC in the wireless multicast service is how to assign different modulation and coding schemes (MCSs) and the time resources to each SVC layer in the heterogeneous channel condition.

Keywords: - scalable video coding (svc), SPIHT algorithm.

I. INTRODUCTION

Unprecedented advancements in 3/4G Broadband Wireless Access (BWA) networks based on Long Term Evolution (LTE), IEEE 802.11 and IEEE 802.16 (WiMAX) standards as well as scalable video coding technologies, such as H.264/MPEG4 et.., Advanced Video Coding (AVC), have made it possible in provisioning large-scale and high-quality wireless video broadcast/multicast applications, such as mobile/wireless Internet Protocol Television (IPTV), etc.

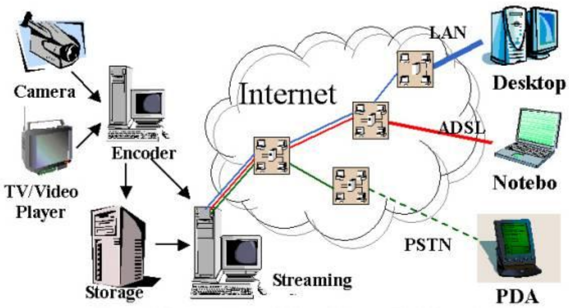

Fig 1: Real Time Transmission

To alleviate the video performance degradation caused by the user who has the worst channel status, scalable video coding (SVC) [4] with adaptive modulation and coding (AMC) provides an excellent solution. In SVC, a video stream is divided into multiple layers. SVC encodes video with the nested dependency: the base layer encodes the basic video quality and higher layers, called the enhancement layers, refine the visual quality from the base layer with smaller quantization granularities.

To enhance the overall performance of wireless multicast video streaming, we assign a low MCS to base layer and high MCSs to

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enhancement layers, so that the users in bad channel conditions receive fewer enhancement layers and obtain basic video quality, while the users in good channel conditions receive more enhancement layers and obtain better video quality.

Video compression methods use signal processing as well as video processing techniques for achieving maximum compression within acceptable quality range. Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) are well known for achieving image compression by exploiting the spatial redundancy of the image. These can achieve very high compression ratios for natural images. DWT has been shown to achieve image compression ratios far beyond than that of DCT. For high resolution images it outperforms the DCT based methods while keeping the perceptual quality of image in acceptable ranges. The trade off in image/video compression is compression ratio versus the perceptual quality. For very high compression ratio usually we get degradation in the perceptual quality. In recent times wavelets based techniques have shown promising results to achieve very high compression within the acceptable quality ranges.

II. EZW (Embedded Zero-tree Wavelet)

Embedded coding is an approach for encoding the transformed coefficients to achieve progressive transmission of compressed image hence we can achieve scalability in image compression by sending only those coefficients that are necessary for image decompression on a specific bit rate[3]. Zero trees allow an efficient coding technique of coefficients that will result in embedded coding.

The process of embedded coding used in EZW is also referred as bit-plane encoding.

Following is the 5 step bit-plane coding process.

Step 1: Set an initial threshold such that will only the first coefficient is greater than the threshold and no other is greater than the threshold.

Step 2: Update the threshold to its half.

Step 3: Significance pass. Scan insignificant values using baseline algorithm. Test each value if it greater than threshold then output the sign of value and set its quantized value to this threshold otherwise set the quantized value for this coefficient to zero.

Step 4: Refinement pass. Scan significant values found with higher threshold values. For each significant value output a zero bit if it belongs to quantized value plus the threshold value interval otherwise output a one bit.

Step 5: Repeat step 2 to 4.

A fast and efficient approach for encoding wavelet coefficients using Embedded Zero tree wavelet (EZW) algorithm. The algorithm has two major strengths. First, the bit stream is embedded and the coefficients are ordered in significance and precision, so that it can be truncated according to the bit-rate requirements of the channel.

Second, it efficiently utilizes the self-similarity between the sub bands of similar orientation and achieves significant data reduction. EZW algorithm is not exactly optimal and some adjustments of parameters (like, initial threshold) may be necessary to make it optimal with respect to a target bit rate. The approach, proposed by Said and Pearlman is known as Set Partitioning in Hierarchical Trees (SPIHT).

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III. SPIHT

The SPIHT algorithm applies the set partitioning rules, defined on the sub band coefficients. The algorithm is identical for both encoder and decoder and no explicit transmission of ordering information, as needed in other progressive transmission algorithms for embedded coding, are necessary[2]. This makes the algorithm more coding efficient as compared to its predecessors. Both the encoder and decoder maintain and continuously update the following three lists, viz.

1. List of Insignificant Pixels (LIP)
2. List of Significant Pixels (LSP)
3. List of Insignificant Sets (LIS)

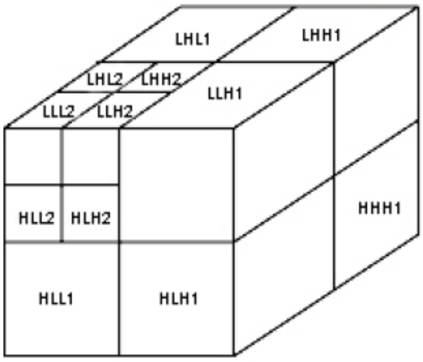

Fig 2: Image pixels separation

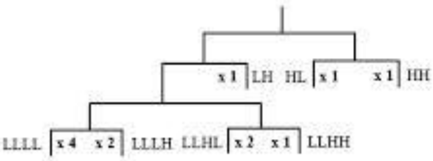

Fig 3: Indicating via Low (L), High (H) pixel values

PSNR scalability can be inherently obtained from SPIHT algorithm. For base layer we may transmit only few significant coefficients. Enhancement layer information can be formed by further allowing refinement in the SPIHT coefficients [4]. PSNR scalability is added into an encoder's bit stream using progressive transmission of bits. Bits corresponding to significant larger in magnitude coefficients in the transformed image, are transmitted earlier than smaller wavelet coefficients. The decoder at the receiver side first displays a coarser image using important bits and as more refinement bits are received, a fine, high quality image with higher PSNR is rendered.

$$CR\,(\%) = 100 \times \left(1 - \frac{compreesed\ size}{original\ size}\right)$$

Hence due to progressive transmission the initial rendered image has low PSNR and as the refinement bits are added PSNR improves.

Depending on the requirement of the receiver and its device capability, it can choose the refinement bits further required to meet the device's requirements.

IV. RESULTS

Following images show how a reference video sequence which is converted to multi resolution from base layer to enhancement layers of the scalable video technique using wavelets with SPIHT algorithm.

Fig 4:

a) Base Layer of sequence: FOOTBALL_352x288_30_orig_01.yuv

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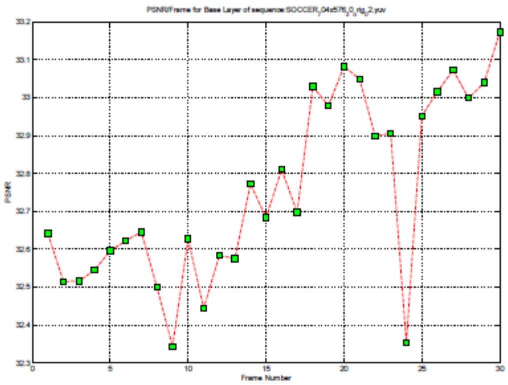

Fig 4:

b) Base Layer of sequence:

PSNR versus frame rate

Fig 5:

a) Enhancement Layer 1 of sequence:

FOOTBALL_352x288_30_orig_01.yuv

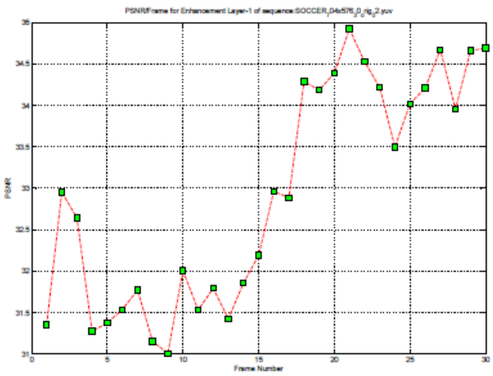

Fig 5:

b) Enhancement Layer 1 of sequence:

PSNR versus frame rate

Fig 6:

a)Enhancement Layer 2 of sequence:

FOOTBALL_352x288_30_orig_01.yuv

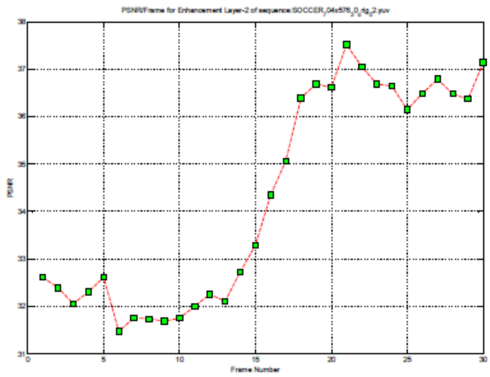

Fig 6:

b)Enhancement Layer 2 of sequence:
PSNR versus frame rate

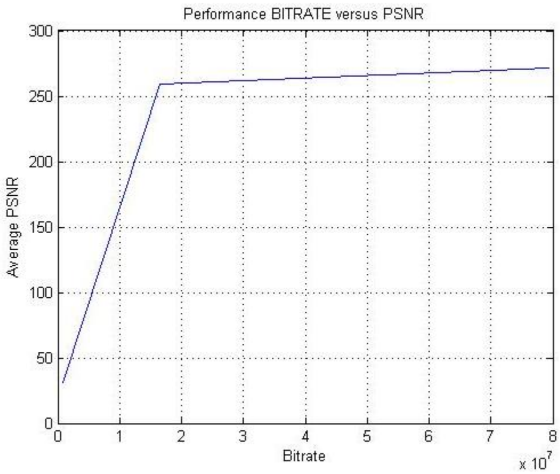

Fig 7: Performance of BIT RATE versus PSNR

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In this paper, the scalable images of resolutions [128 x128 x3], [256 x256 x3] and [512 x512 x3] are obtained using MATLAB. The above figures states the enhancement layers are more precise in transmission and the performance of the BIT RATE and PSNR is also shown. More over the compression ratios for different videos with same layers are compared in the table given below.

Video names	BASE LAYER	ENHANCEMENT LAYER 1	ENHANCEMENT LAYER 2
FOREMAN352x288	6.5413	0.9632	0.7939
MOBILE352x288	3.4991	0.93333	0.7887
FOOTBALL352x288	5.1268	0.9542	0.7824
ICE_352x288	8.3841	0.9710	0.7952

Table 1: Compression Ratios for each layers of SVC

Thus any video can be implemented with SVC multicast using SPIHT algorithm. The differences in the compression ratios of the SVC layers are also stated in the above table.

V. CONCLUSION

Here the implementation of a Scalable video multicast based video compression SPIHT algorithm on MATLAB and provided experimental results. When SVC coding scenario meets the circumstances, proposed method should be useful. With the apparent gains in compression efficiency, the proposed method could open new horizons in video compression domain; it strongly exploits temporal redundancy with the minimum of processing complexity which facilitates its implementation in video embedded systems.

VI. FUTURE SCOPE

The transmission of fps (frames per second) can be varied to different destinations based on the number of layers in SVC technique. Moreover live recording and viewing process can be improved in parameters like quality and quantity.

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