Adaptation Scheme for Improved Multimedia Communication

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Abstract - The growth and application of mobile devices in accessing multimedia contents, including mobile video calls and distribution of images among people globally is constraining the wireless network resources. Due to dynamic nature of wireless network and limited networking resources, adaptation scheme for improved multimedia communication is proposed. Considering the impact of channel errors on received mobile video quality performance, the scheme employs adaptation process in the design process. The scheme improves received video quality performance by systematically adapting the encoding parameters for efficient delivery of video streams. Performance of the proposed scheme is tested using simulated wireless model. The result shows that the proposed scheme can improve the quality of multimedia communication over error prone wireless channel.

***Index Terms*— Adaptation, multimedia, communication, video quality**.

I. INTRODUCTION

Multimedia contents include texts, images and video [1]. Video content requires more network resources for efficient distribution compared to text and images. The distribution of video contents over wireless channel to users is increasing in demand due to its flexibility and accessibility. However, compressed media streams experience high error rates due to certain factors including fading, interference, pathloss. These factors affect the received video quality performance. H.264/AVC [2] supports error-resilient features such as data partitioning, intra update, slice interleaving for robustness of media stream over error prone channels. However, the error-resilience schemes in the source compression is not enough to combat the impact of channel distortions on received video quality performance, hence requires advanced protection scheme to improve received video quality performance. Conventionally, impacts of channel errors can be controlled by Automatic Re-transmission on Request (ARQ) approach where the corrupted video packets are retransmitted in response to receiver requests. However, ARQ incurred delays in process of
retransmission of loss video packets. Hence, ARQ may not be suitable for delay sensitive video applications. Channel coding such as Forward Error Correction maybe employed in video communication system to enhance the reliability of transmitted video streams over error prone channel. In video transmission, the process of adding extra video packets (redundancy) to enhance error resiliency incur extra cost (more bandwidth requirement) and delays. Advancement in mobile communication system has made it possible to exploit adaptive modulation scheme in improving the quality of video transmission over error prone channel. Several applications of adaptive modulation scheme are found in the literature [3] [4] [5], where the modulation parameters are adapted based on the channel conditions. In addition to the literature, improving received video quality performance by adaptation of video packetisation strategy for efficient delivery on error prone wireless channel is discussed in this paper.

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II. THE PROPOSED SCHEME

Content Adaptation Transmission (CAHT) Scheme for Improved Multimedia Communication is proposed in this paper. The scheme aims at enhancing robustness of compressed video streams over error prone channel and improves received video quality performance. In the proposed scheme, the adaptation of video packets size is based on the error sensitivity of the video streams. The error sensitivity of video stream is characterized by its degree of distortion by channel errors. Video streams with high distortion characterization are highly prioritized. The prioritized video packets are grouped into different classes of protection according to the distortion characteristic of the media streams.

III. SYSTEM ARCHITECTURE

The proposed system architecture composes of transmission and receiving sections. The transmission process includes capturing, encoding and transmission while the receiving end consists of decoder and display unit. Multimedia communications involve video, text and images distribution. The transmission chain starts from encoding of media content to match the available limited network resources. The encoding process includes capturing of natural scene by digital video camera and application of compression algorithms to remove the redundancy and enhance robustness of the compressed media streams prior to transmission over

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delivery channel. The encoding block performs video compression function by exploiting redundancies in video sequence and application of various algorithms to enhance robustness of the media streams. The proposed scheme employs distortion characterization of media streams in the adaptation process. The adaptation process include intelligent packetization of the media stream based on the distortion characteristic of the media stream. Wireless video communication is more challenging due to high bit error rates which degrade received video quality performance. The transmitted media stream is decoded at the receiving section and reconstructed. The reconstructed media stream is processed and displayed on the mobile devices for individual consumption. More details on the multimedia communication systems including digital video compression, transmission and decoding are discussed in the literature [6][7].

Distortion [8] characteristic of media stream in this context is defined as the magnitude of distortion of the media stream. Changes in the distortion characteristics between successive video scenes are mainly caused by object motion and global motion. In object motion, different objects experience different motion characteristics in the video scene. In camera motion, objects within the video scene experience similar motion. Since camera motion produces homogeneous motion characteristic within the video scene, motion compensation results in reduction of residual energy and an increase in compression performance. Thus, in this work object motion is considered as the influential parameter in the distortion analysis.

IV. SIMULATION

Simulations are performed to assess the effectiveness of the proposed adaptation scheme. The distortion characterization of the media streams is analyzed using the look-up table generated experimentally. Distortion level of standard test video sequences are analyzed. H.264/AVC reference software [9] is used in the experiment. H.264/AVC encoder performs encoding and error resiliency functionalities including packetization for improved transportation of media streams over wireless network. The encoding parameters for media streams are adapted based on the distortion level of the media stream. The performance of the proposed scheme is tested with Football standard test video sequence. The compression configuration of the video streams include frame rate of 30fps, CIF 352x288 spatial resolutions and a macroblock size of 16×16 pixels. Each test video sequence has a total number of 300 frames. The received video streams are decoded using H.264/AVC reference software. The transmission of the compressed video streams is simulated at different channel conditions. The channel performance is carried out with pre-simulated error patterns composed of traces of different Signal-to-Noise Ratio. The pre-simulated error traces is used to corrupt the video streams transmitted through the simulator.

The performance of the proposed scheme is measured in terms of received video quality. As a measure of perceived video quality performance, Peak-Signal-to-Noise-Ratio (PSNR) model is used in the received video quality performance assessment [10][11][12]. The overall video quality is obtained by averaging the PSNR values throughout the video sequence. Higher PSNR values indicate better video quality performance. Although, PSNR is not the most reliable metric of video quality assessment, it is employed in the research because it is less complex and widely used for video quality assessment.

V. RESULTS AND DISCUSSIONS

The performance of the proposed adaptation system is tested with Football standard test video sequence in CIF format. The results are obtained by averaging the PSNR video quality performance values. Figure 1 presents the received video quality performance in terms of PSNR values of the transmitted media streams. Comparing the results obtained under different channel conditions: it is observed that the proposed scheme: Content Adaptation Hybrid Transmission Scheme (CAHT) outperforms LPS approach in terms of the received video quality performance measured in PSNR(dB). The reason for quality enhancement as observed in the case of CAHT compared to LPS is a result of improvement of error protection scheme of the transmitted video stream. The improvement of error protection scheme of the video streams is a result of systematic adaptation of video packets. The adaptation scheme improves robustness of the media stream for improved quality performance. The result is presented in Figure 1.

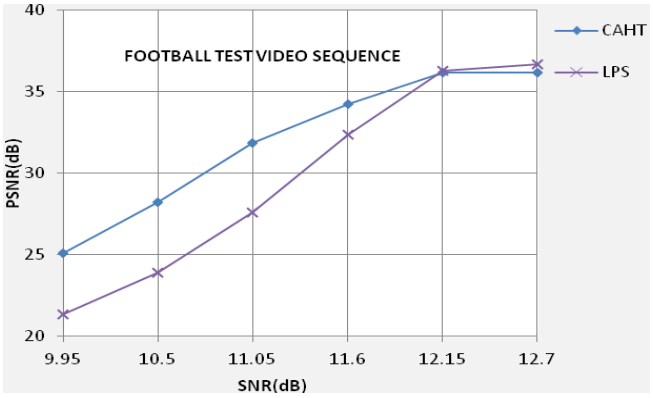

Figure 1: Video quality performance for Football Test video sequence.

The quality performance of Football test video sequences is presented in Figure 1. It is observed from the result that at the same source bitrates, video quality performance at CAHT is enhanced compared to the video quality performance at LPS. The reason for the quality performance enhancement in CAHT is attributed to the fact that more robust adaptation scheme is applied by adapting the video packet sizes of the test media stream.

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VI. CONCLUSION AND FUTURE WORK

Adaptation Scheme for improved Multimedia Communication has been discussed in this paper. The paper first investigated various video transmission schemes. In contrast to the exiting mechanisms in the literature, it proposed a simple adaptation scheme for error protection of video streams over error prone channel by adapting video packetisation scheme based on distortion level of the video stream. Test results show significant enhancement in the received video quality performance. Future work includes testing the algorithm with more standard test video sequences to assess efficiency of the scheme.

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