Society for Science and Education United Kingdom
AIVP Advances in Image and Video Processing
Volume 4, Issue 4
ISSN 2054-7412

Content-Aware Adaptive Mechanism for Improved Digital Multimedia Delivery over Wireless channel

[1]U. Ukommi, [2]U. Akpan and [3]S. Garba
[1] *Department of Electrical and Electronic Engineering, Akwa Ibom State University, Nigeria.*
[2] *Department of Electrical and Electronic Engineering, University of Uyo, Nigeria.*
[3] *Nigerian Communication Commission, Nigeria*
uukommi@yahoo.com

ABSTRACT

Meeting users' satisfaction in terms of received quality of mobile media services are challenging due to dynamic channel condition and system constraints. Adaptive coding and modulation techniques improve system capacity. In this study, Content-Aware Adaptive Mechanism is investigated for improved wireless multimedia communications. The unique features of this contribution include the mechanism to exploit multimedia characteristic in the adaptation of modulation parameters for transmission of media bitstream. The aim of the study is to model an end-to-end transmission scheme capable of maximizing the limited network resources for improved mobile multimedia communications. The experimental results obtained under various test conditions demonstrate the efficiency of the proposed scheme compared to the conventional mechanism.

Index terms: Content, wireless channel, multimedia communications, coding, media quality.

1 Introduction

It is challenging to meet the users' demand of immersive mobile multimedia quality through wireless network due to certain factors. Among the key factors that determine the success of mobile multimedia communication delivery include, media contents, pricing, media quality and network resources. Most often, wireless system is bandwidth limited, this adversely affect the quality of multimedia delivery over the wireless network. Conventionally, one-way broadcast television service was the original television delivery approach. Many broadcast television systems have evolved from analogue to digital to mobile standards. The mobile digital television is delivered through wireless platform to users' mobile devices, home television sets. With the wireless platform, timely information, including emergency information and videos can be broadcast to mobile users at anywhere at anytime. The evolution of 4G wireless networks with mobile internet facilitate multimedia streaming on smartphones, laptops and smart televisions, providing wider network coverage compared to the conventional wired network service. Typically, Long Term Evolution (LTE) and Worldwide Interoperability for Microwave Access (WiMAX) are the 4G mobile communication standards that support ubiquitous access [1]. The technologies facilitate multimedia (voice, video and pictures) distribution. These technologies offer considerable advantages over satellite and digital television broadcast. However, there are technical challenges that must be resolved to facilitate holistic deployment and utilisation of the platform for advanced multimedia services. The multimedia services include distribution of video and streaming of live event through mobile network to friends and audience at another location with internet connectivity and receiving device such as laptop,

DOI: 10.14738/aivp.44.2917
Publication Date: 25th August, 2016
URL: http://dx.doi.org/10.14738/aivp.44.2917

mobile devices and television sets. However, the proliferation of smartphones and sharp increase in the demand of mobile multimedia services result in constrained network due to limited bandwidth. This paper presents a novel approach to enhance distribution of digital multimedia services over constrained wireless network.

1.1 The Mechanism

Multimedia communication system includes audio, pictures and video communication. It involves capturing of events, coding and distribution, involving transmission of the coded media streams to respective users. The source encoding tools play significantly role in the end to end media quality. It supports error-resilient features such as data partitioning, intra update, slice interleaving for enhanced robustness of media stream and improved received media quality performance. However, the error-resilience schemes supported in the source encoder is not enough to combat the impact of channel distortion on received media quality, hence requires advanced protection technique to mitigate the impact of channel errors on the media quality. Conventionally, impact of channel errors are usually control using channel coding mechanism, Forward Error Correction and Automatic Repeat Request (ARQ) where the corrupted media packets are retransmitted during timeouts, or in response to receiver requests [2]. However, for highly sensitive multimedia applications, the redundancy transmitted with media packets incur extra cost (more bandwidth requirement). ARQ also incurred delays by retransmission of loss media packets which is usually very annoying for non delay media e.g transmission of live football event. Advancement in mobile communication system has make it possible to employ Multilevel Quadrature Amplitude Modulation (MQAM) [3][4] for high-bit-rate transmission using a constrained-bandwidth. Adaptive Modulation Scheme is also applied to improve the quality of multimedia transmission over a fading channel. Several applications of Adaptive modulation Scheme are found in the literature [5][6]. In [7][8] advanced modulation and hierarchical QAM design for transmission of layered H.264/AVC is investigated [9]. However, MQAM requires higher energy per bit-to-noise spectral density to achieve the same quality as lower modulation scheme technique such as Binary Phase-Shift Keying and Quaternary Phase-Shift Keying. In contrast to the existing applications, exploiting the multimedia characteristic in the adaptation of transmission of media stream is the unique feature application. In the system, the transmission parameters are adapted according to the multimedia characteristic, such that multimedia content that are prone to channel errors are given more channel protection requirement. The system selects for each multimedia portion the optimal transmission parameters that maximise the received multimedia quality. The objective of the scheme is to enhance the robustness of the significant multimedia portion that is sensitive to impact of channel errors for improved reliability and received multimedia quality under constrained-network. The algorithm selects improved transmission parameters in terms of modulation scheme for media portion characterised with relative activity and effect transmission of less prioritised media frame with normal parameters, while taking into consideration the conventional optimisation parameters, prevailing channel conditions. However, when the channel condition is in good state the system adapts to normal allocation strategy to achieve good throughput and improved multimedia quality.

2 The System Model

The system mechanism exploits the advantage of different importance and error sensitivity of different groups of media bitstream to channel errors in developing the system algorithm. Different portions of media stream have different importance and contribute differently towards the overall reconstructed media quality. In this concept the focus is on improvement of the received media quality. Different parts of the media portion are prioritised into different level according to the significant of the media packets. Group of media packet is marked based on its importance to facilitate identification and protection of the significant media data in the physical layer. Systematic mapping of different media packets onto different constellation is performed based on importance of the media packets in order to enhance the robustness of the significant packet that guarantees low degradation of received media stream for smooth reconstructed media quality. Unequal Error Protection scheme is employed, which the most vulnerable and significant media packets are mapped onto more robust constellation while the less significant media packets are mapped onto the less robust constellation for transmission. The media stream to be transmitted is classified into high and low priorities. The prioritisation is based on the activity weight of the media packet of the segmented portion of media stream. The media packet with high weight is prioritised over low weighted media packet. The high priority is transmitted on more robust channel and the low priority is mapped onto less robust channel for transmission. The transmission mechanism enhances protection and reliability of the high priority media packets against impact of channel errors for improved smooth reconstructed media quality. The framework of the proposed model is presented in figure 1, consisting of source, channel and transmission chain.

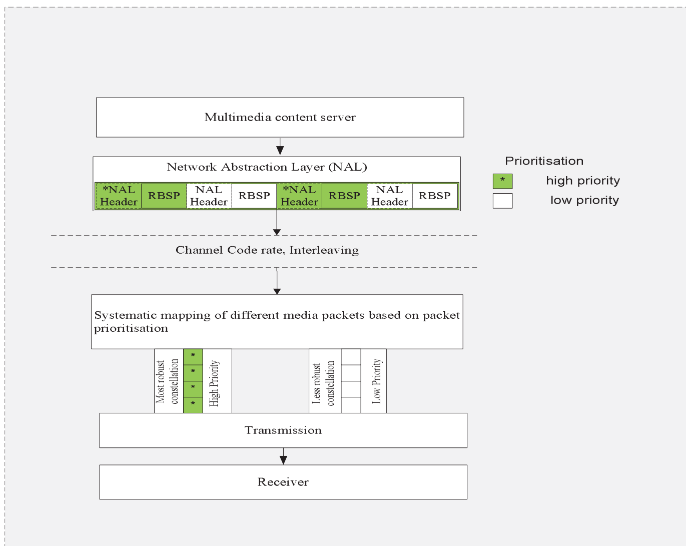

Figure 1: System Model

Figure 1 shows the system model consisting of multimedia content server performing source encoding. Each media frame is divided into slices, containing macroblocks which are mapped to Network Abstraction Layer (NAL), the interface between the media encoder and the transport layer. NAL encapsulates the coded media stream into Network Abstraction Layer Units to facilitate robustness of the encoded media stream against impact of channel errors. Each nework abstraction layer unit can be described as a packet that contains a header and a Raw Bytes Sequence Payload (RBSP). The header identifies the Network abstraction layer unit and priority and the payload contains the coded media data. The network abstraction layer units are mapped onto transport layer for channel coding and interleaving to minimize end-to-end distortion and enhance robustness and reliability of the compressed media stream over error prone channel. Adaptive mechanism is applied, different media stream are systematically mapped onto different constellation for transmission based on the priority of the media stream. The important packets are transmitted on robust channel compared to low priority being transmitted on less robust channel. The basic steps in the development of the scheme include selection algorithm for the transmission scheme and prioritisation of the media portion based on the dynamic content characterisation of the media stream.

3 Prioritisation of Media Stream

Prioritization of the media stream is based on the dynamic characterisation of the media content [10][11]. The media portion with high dynamic characterisation is prioritised as most significant part and the segment with static or relative low activity content is classified as lower priority. The characterisation is based on the concept that motion data is more significant for received media quality compared to the low motion or texture data. The lost of high motion data degrades the received media quality significantly compared to texture data which can easily be concealed at the receiver. Thus, the media segment with high dynamic characterisation is given more attention and protection because the motion part contributes significantly to the overall received media quality compared to the static portion. Thus, the mechanism focuses on the protection of the media segment with high prioritisation to enhance its robustness against channel errors.

4 Simulation

The performance of the proposed scheme is tested using integrated H.264/AVC and simulated mobile channel for digital multimedia streaming scenario. The standard test media sequences are used for analysis. The test media samples are in Quarter Common Intermediate Format with a frame rate of 30 frames per second. The first frame is intra coded and subsequence frames are predictive coded. Each test media sequence is prioritised into the high and the low priorities based on the media content significant and compressed into separate substreams for transmission. At the Network Abstraction Layer, the compressed media stream is divided into smaller units (packets) to enhance robustness of the compressed media stream over wireless channel. At the physical layer, two different transmission schemes are employed. Media packets are mapped onto different transmission scheme based the priority for transmission. The importance media packets are mapped on more robust transmission scheme and the low priority media packets are transmitted on the less robust transmission scheme. At the decoder, error concealment algorithm is applied in decoding the transmitted media stream. The distortion incurred by the transmission errors is measured in terms of the average PSNR between the encoded and corrupted media stream.

5 Results And Discussions

The evaluation of the scheme in terms of quality performance of the transmitted media stream is presented in figure 2. The media performances measured in terms of average PSNR values in three different simulated scenarios are analysed. Without UEP represents a scenario of equal transmission parameters to the different media stream. MA-UEP represents a scenario where the high priority media stream is transmitted on robust channel. The third case, MA-EUEP presents a scenario where the high priority media portion is further optimised by adapting the packetisation structure of the high priority media packets.

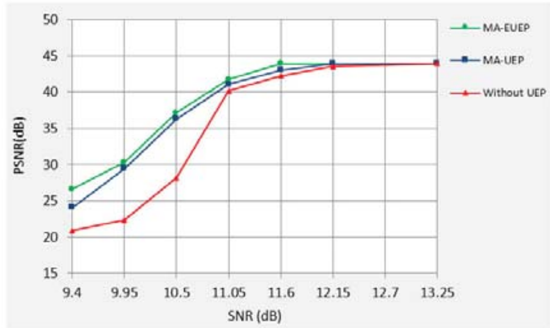

Figure 2 Quality performance of the scheme

The performance of the proposed scheme is depicted in Figure 2. The scheme is more effective on low SNR range. The gain in PSNR performance is a result of reduction in the number of losses of importance media packets. The MA-EUEP test scenario shows improved performance due to effective packetisation structure adapted in the process.

6 Conclusion

This article presented content-Aware Adaptive scheme for improved digital multimedia delivery over wireless channel. The scheme improves the received media quality over wireless channel by separating media stream into different groups. The media portions are prioritised based on their significance and contribution to the overall reconstructed media quality. The scheme is devised using adaptive transmission and packetisation mechanism to enhance the robustness of the transmitted media stream over error prone channel. The knowledge gained in the research work is very useful in developing advanced system for immersive multimedia communications.

REFERENCES

[1] A. Bleicher, "LTE-Advanced is the Real 4G", Spectrum, IEEE, 2013.

[2] W. T. Webb, "The modulation scheme for future mobile radio communications," *Electronics and Communication Engineering Journal,* pp. 167-176, August 1992.

[3] S. Sampei, "Rayleigh Fading Compensation for QAM in Land Mobile Radio Communications," *IEEE Transactions on Veh. Tech.,* vol. 42, pp. 137-147, 1993.

[4] T. Ue, S. Sampei, and N. Morinaga, "Symbol rate and modulation level controlled adaptive modulation system with TDMA/TDD for high bit rate transmission in high delay spread environments," *Electronics Letters,* vol. 32, pp. 304-305, 1996.

[5] A. J. Goldsmith and S. G. Chua, "Adaptive coded modulation for fading channels," *Communications, IEEE Transactions on,* vol. 46, pp. 595-602, 1998.

[6] L. F. Wei, "Coded modulation with unequal error protection," *Communications, IEEE Transactions on,* vol. 41, pp. 1439-1449, 1993.

[7] M. M. Ghandi, "Layered H.264 video transmission with hierarchical QAM," *Elsevier,* 2006.

[8] S. Chennakeshu and J. B. Anderson, "A new symbol error rate calculation for Rayleigh fading multichannel reception of MPSK signals," in *Vehicular Technology Conference, 1993 IEEE 43rd*, 1993, pp. 758-761.

[9] T. Ue, S. Sampei, and N. Morinaga, "Symbol rate and modulation level controlled adaptive modulation/TDMA/TDD for personal communication systems," in *Vehicular Technology Conference, 1995 IEEE 45th*, 1995, pp. 306-310 vol.1.

[10] L. Kuen-Han and W. Chieh-Chih, "Stereo-based simultaneous localization, mapping and moving object tracking," in *Intelligent Robots and Systems (IROS), 2010 IEEE/RSJ International Conference on*, 2010, pp. 3975-3980.

[11] Y. Sheikh and M. Shah, "Bayesian modeling of dynamic scenes for object detection," *Pattern Analysis and Machine Intelligence, IEEE Transactions on,* vol. 27, pp. 1778-1792, 2005.