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An End-To-End Video Transmission System over Various Wireless Environments

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ABSTRACT: This paper presents framework for video transmission over wireless networks with LDPC based error correction mechanism to ensure error free data delivery with H.264 AVC video encoder to cope up with limited bandwidth issue. Video stream were transmitted over wireless network and compared for Bit Error Rate. The wireless link between sender and transmitter is considered to have characteristics of AWGN, Rayleigh, Nakagami and Rician fading environment. This paper is organized as follows: section-II describes related work in the field of efficient video transmission followed by the basics of forward error correction schemes in section-III. Section-IV represents proposed video transmission algorithm and section-V contains experimental setup and simulation results. Finally section-VI concludes this paper.

KEYWORDS - Wireless networks, video encoding, Bit Error rate, Forward error correction, Low density parity check.

1. INTRODUCTION

With the rapid growth of wireless services from voice communication services to high speed data and multimedia communication services various emergingwireless multimedia transmission techniques have found application in pervasive and ubiquitous applications such as health care, environmental monitoring, security and surveillance. Multimedia applications for example video streaming are characterized to be delay sensitive and bandwidth intensive. These applications need higher degree of QoS requirement while existing wireless network technology provides limited bandwidth and time-variant QoS support for these applications. Limited bandwidth requires the video to be compressed prior to the transmission. H.264 AVC is a rich video compression standard jointly developed by the ITU and ISO [1] to support improved coding efficiency and improved network adaptation while maintaining the same quality level. H.264/AVC encoder converts digital video to a format that requires lesser capacity while storing or transmitting. This compressed video stream is also susceptible to channel imperfections since corrupted packets tempt different levels of quality deprivation as a result of temporal and spatial dependencies.

Error propagation is the most important issue in the video transmission because an error in current reference frame is propagated to all future reconstructed frames by the decoder, since the prediction of future frames is dependent reference frame. This issue has led research community towards the design of error-resiliency features, for e.g. data partitioning, error concealment techniques and flexible macroblock ordering (FMO) [2] in H.264 [1, 3, 4].Recent researches have demonstrated that Forward error correction (FEC) schemes have been widely used in order to protect video data against channel impairments to provide successful data transmission and to avoid costly retransmissions [5-7]. Yet, the maximum throughput does not ensures the minimum video distortion at the receiver end since the video data are delay sensitive and retransmission of corrupted packets may not be viable. Furthermore unlike the data packets, compressed video packets tends different amount of distortion in the received video stream. A forward error correction code with unequal error protection capability is more useful in video streaming applications since they provide higher protection to high priority packets and vice versa comparison to equal error protection schemes where protection does not depends on priority of packets. In such a way considerable quality improvement can be provided by UEP-FEC codes [8, 9].

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II. RELATED WORK:

A number of solutions have been provided for effective multimedia streaming through wireless networks. Application layer packetization and joint source-channel coding [11] based approach has been proposed for robust multimedia transmission over error-prone wireless network. Girod, Bernd, et al [12] proposed channel-adaptive scheme for multimedia streaming. An opportunistic scheduling algorithm to support multimedia transmission has been proposed [13] that utilizes a priority function based on channel conditions, queue size multiplexing gain and frame priority. A cross layer scheduling approach with adaptive modulation and coding is presented in [14]. Authors in [15] proposed adaptation mechanism where application layer and lower layer are combined for low-delay wireless video streaming. Error control and adaptation mechanism for error-free video transmission are proposed by Van Der et al [16].Coopetition based mechanism in proposed in [17], in this mechanism wireless stations can optimally and dynamically adapt their cross layer transmission strategies to improve multimedia quality and power consumption. Application driven cross-layer optimization framework for wireless streaming has been presented in [18, 19].

Forward Error Correction Principles
Forward error correction techniques are used to ensure error free data delivery in real-time communication scenario. FEC approaches allow the receiver to improve errors/losses with no additionally discussion with the transmitter. Error correction codes transforms k data bits into n encoded data bits where n>k,typically, the first k data bits ineach frame are similar to the original k sourcedata; the remaining (n – k) data are referred toas parity bits (Fig. 1). Block diagram of forward error correction codes. This paper utilizes Low Density Parity Check (LDPC) based FEC scheme. The advantages of LDPC codes are as follows:

- LDPC uses XOR operations for high-speed encoding/decoding, which are more appropriate for handheld devices.
- LDPC operate on very large source blocks

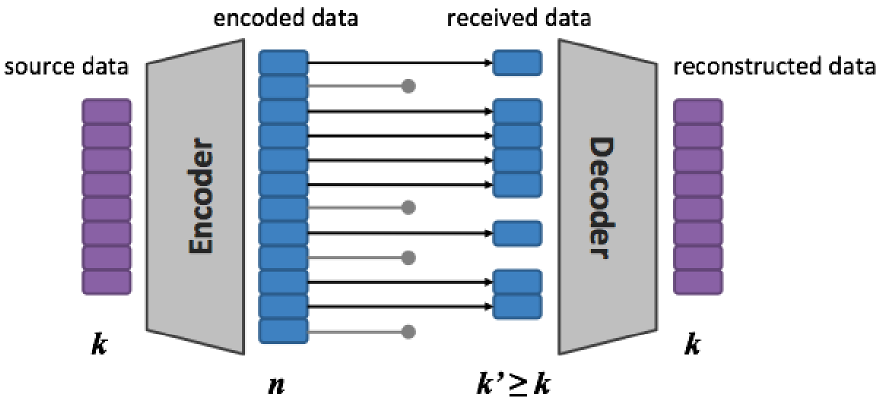

Figure 1. Forward Error Correction Code

III. PROPOSED WORK

This research work is extension of work done by Shibi K [10], in previous work the author have proposed the "end-to-end video transmission system over wireless sensor network".This paper is focused towards the delivery of multimedia streaming over wireless networks such as wireless LANs.The proposed video transmission methodology adapts H.264 AVC encoder for video compression along with LDPC based FEC technique to guarantee error free data transmission over wireless fading environment. The process of video transmission starts with H.264 video encoder part where the input video stream is converted into frames than each frame is process through Inter prediction/Construction or Intra prediction/Construction unit for removal for temporal and spatial redundancy respectively. Inter prediction/construction block requires current frame with reference frame to calculate temporal redundancy with the help of motion vector of current block. The search space is taken to be double of block size N. Sum of absolute difference (SAD) algorithm is used for motion vector calculation. Finally the prediction error is calculated by the difference of current frame and predicted frame pointed by the motion vector. Inter prediction /reconstruction unit adds the motion vector to current

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frame and reconstructs new frame. Inter error calculation unit calculates error between current frame and reconstructed frame. If this mean error is less than the predefined threshold value than the reconstructed image is considered to be correct else Intra frame prediction is done. Intra frame prediction module does not requires reference frame for redundancy calculation. It has nine modes of operation in case of block size 4×4 and four modes in case of block size either 8×8 or 16×16. The mode of operation selected by intra frame prediction block is also conveyed to intra frame reconstruction module known as spatial redundancy prediction module. Again mean error is calculated through intra error calculation unit and prediction error between current frame and reconstructed frame is compared with threshold value. If the prediction error is less than the predefined threshold than only intra frame prediction is found to be correct else if the threshold error is greater than inter frame prediction error and intra frame prediction error than data is sent directly without any compression. Finally the encoded frame is ready to be transmitted and given to wireless network for data transmission.Each encoded frame is first converted to serial stream of data, zero padded and packetized. These data packets are now encoded by LDPC based forward error correction scheme, modulated by BPSK modulator and transmitted over AWGN, Rayleigh, Rician and Nakagami channels. At the receiver end, the received data packet is decode through bit-flip algorithm. After successful decoding, data packet is demodulated, reconstructed as image frame and applied to standard H.264 decoder for decompression. H.264 decoder block uses encoded information saved at encoder as per the encoder information, decoder performs inter frame prediction, intra frame prediction or direct data transmission modes to reconstruct the decompressed frame. Finally decompressed frame is now compared with transmitted frame to calculate mean square error (MSE) and PSNR. Block diagram of the proposed work is shown in figure-2:

IV.EXPERIMENTAL SETUP

This research work proposes novel end-to-end video transmission system over wireless networks. To evaluate the performance of our proposed system MATLAB based framework is considered and 10 frames from given video stream were transmitted over wireless network and compared for Bit Error Rate. The wireless link between sender and transmitter is considered to have characteristics of AWGN, Rayleigh, Nakagami and Rician fading environment.

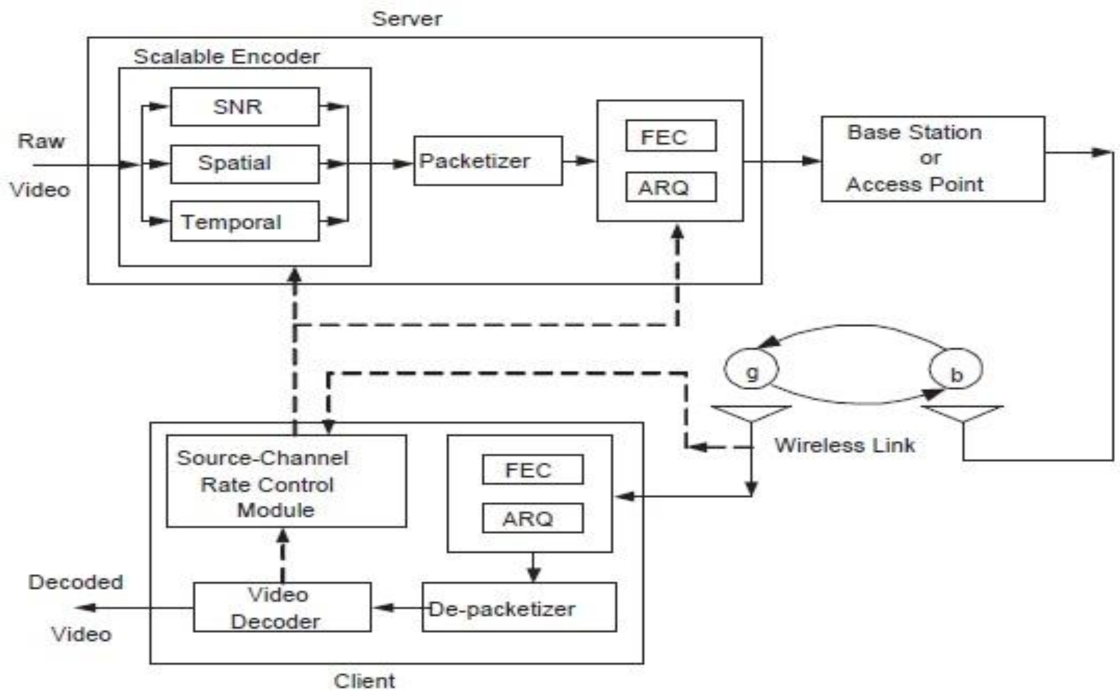

Figure 2. Proposed end-to-end video transmission system

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V. RESULTS AND DISCUSSION

Step by step simulation results for our research work are given in figures below, image frame to be transmitted is shown in fig-3, fig-4 represents encoded image frame by H.264 encoder. The frames received at receiver end and decompressed by H.264 decoder are given in fig-7 and fig-8 respectively. BER performance for proposed system is given in table-1.

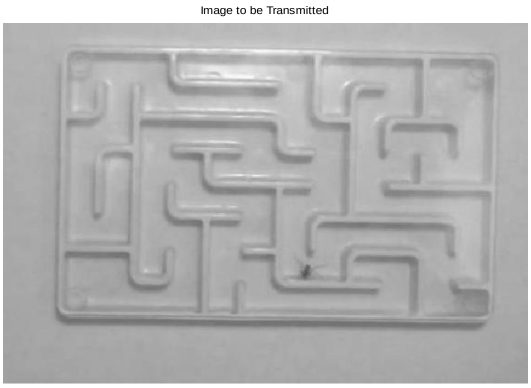

Figure 3. Image Frame to be transmitted

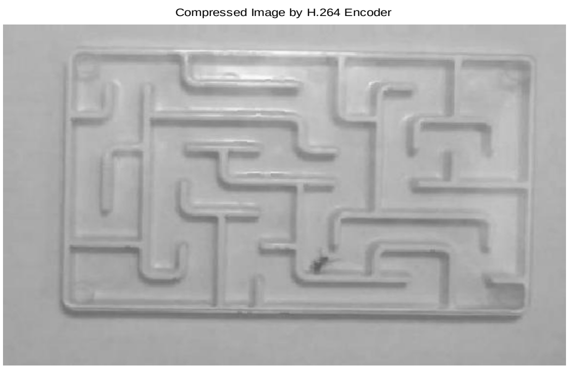

Figure 4. Compressed Image by H.264 encoder

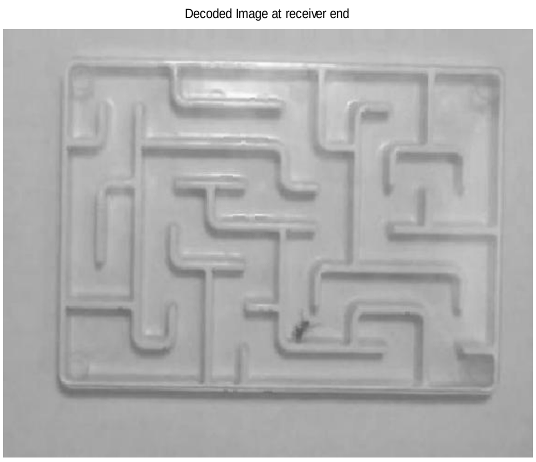

Figure 5. Reconstructed image at receiver's end

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Figure6. Decompressed image at H.264 decoder

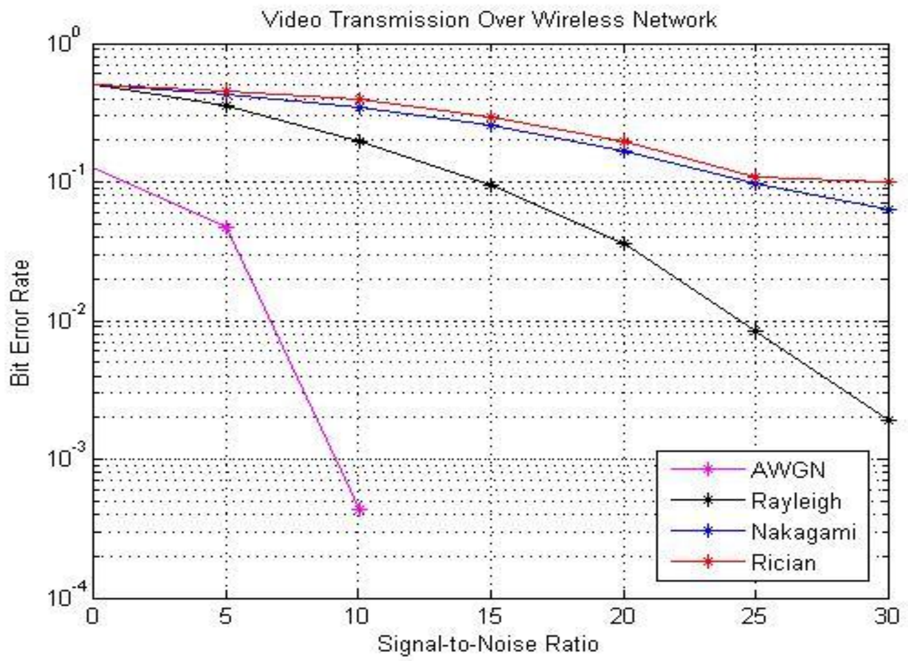

Figure7. Comparison of simulated BER for proposed video transmission system

Table1. Comparison of BER performance for different fading environment

SNR	BER(AWGN)	BER(Rayleigh)	BER(Nakagami)	BER(Rician)
0	0.1256	0.4982	0.4987	0.5064
5	0.0473	0.3572	0.4259	0.4573
10	0.0004	0.1964	0.3468	0.3955
15	0	0.0943	0.2592	0.2942
20	0	0.0362	0.1672	0.1968
25	0	0.0084	0.0985	0.1082
30	0	0.0019	0.0641	0.0987

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VI.CONCLUSION

MATLAB based framework for end-to-end video transmission over wireless multimedia sensor network is developed in this research. H.264 AVC encoder/decoder is used for data compression followed by Low density Parity Check (LDPC) based forward error correction scheme to ensure error free transmission. To evaluate the performance of our proposed scheme Bit Error Rate is taken as reference parameters. Simulation results shows that our proposed scheme performs best in case of AWGN environment. As compared to Rayleigh environment our scheme performs 15dB better in AWGN environment.

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