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Implementing a Robust Video Transmission Mechanism for Wireless Ad Hoc Networks

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Abstract: Wireless ad hoc networks became popular as they can be built with ease. Due to the innovations in the technologies, now they are able to have higher bandwidth in such a way that they can transmit videos as well. However, achieving high video quality is a challenging task in such networks due to the inherent limitations in the networks. In order to improve the quality of video transmission in this network, many techniques came into existnace. Recently Zhu et al. proposed Systematic Lossy Error Protection (SLEP) that proved to be robust. This technique is capble of estimating errors as well while transmitting videos over ad hoc networks. At the application layer level, this technique could outpefrm other such schemes. In this paper we built a prototype application that simulates the SLEP scheme. The scheme is implemented to demonstrated the proof of concept. The packet loss ratio and PSNR measures are considered for experients. The quality of decoding has been tested with the prototype application. The results reveal that the proposed system outperforms existing ones in terms of quality and accuracy of video transmission besides packet loss ratio estimation.

Index Terms – Wireless ad hoc networks, video transmission, lossy error protection, error estimation

I. INTRODUCTION

Ad hoc wireless networks work without fixed infrastructure. Ad hoc network is a collection of nodes that are self configured. They are handy in case of emergencies. Deployment of such network is very easy. In case of search and rescue operations when normal communication networks are absent or unavailable temporarily, ad hoc networks play a vital role. As there are innovations in the electronic technologies, the ad hoc networks are used for heavy duty jobs such as video streaming. However there are many technical challenges that need to be overcome in order to succeed in video transmission in such networks. This is due to the inherent problems in ad hoc networks that are not like conventional networks. Fluctuations over time can disrupt video transmissions or ensure mediocre performance with respect to video transmissions. A typical wireless ad hoc network is as shown in Figure 1.

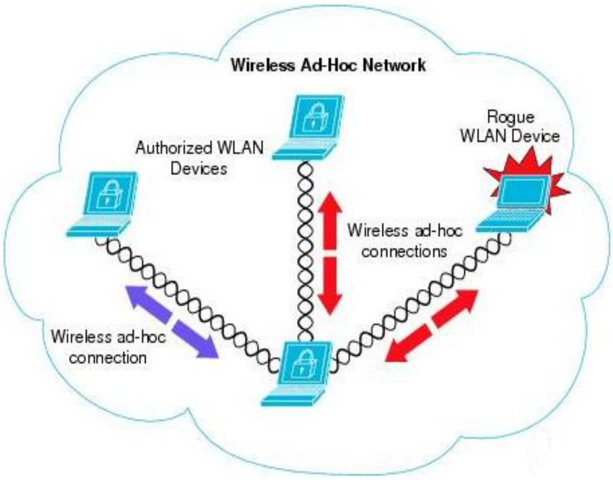

Figure 1 – Wireless Ad Hoc Network

As can be seen in Figure 1, it is shown that wireless devices are formed as a network without any fixed infrastructure. Such network is known as infrastructure less network. The nodes in the network participate in communications after formed into a network with self-configurations. Since these channels fluctuate, it is essential to have some sort of protection. Forward Error Correction (FEC) is one of the techniques that work at the application layer. This is used in the retransmission schemes in order to ensure that the video streaming does not loss data. Correct estimation of packet loss ratio (PLR) is important to make well informed decisions. Many techniques came into existence to safeguard video streaming in such networks. Recently Zhu et al. proposed a technique known as Systematic Lossy Error Protection (SLEP) to ensure resilient video transmissions in wireless ad hoc networks. The technique was based on the ideas pertaining to video coding that helps in video streaming. In this paper we implement SLEP using a prototype application that demonstrates the proof of concept. The empirical results reveal that the SLEP scheme works better than other existing schemes with respect to quality and accuracy of video streaming. The remainder of the paper is structured as follows. Section 2 reviews literature. Section 3 presents the proposed system. Section 4 presents experimental results while section 5 concludes the paper besides providing directions for future work.

II. RELATED WORKS

This section reviews literature on the video streaming issues in wireless ad hoc networks. The work in this paper is based on the work proposed in [1]. The SLEP model proposed in [1] was in turn based on the systematic lossy source-channel coding [2]. An analogue channel is used to transmit analogue source without coding. The same is sent with encoding in digital channel. The systematic error-correcting channel has been enhanced and the term systematic coding is introduced. For such configurations, systematic approach was provided with theoretical bounds and conditions in [3]. Many researches came into existence on lossy compression [3], [4], and [5]. However, the side information is made available at decoder. Rate distortion function is used in the research as there was distortion when video streaming was carried out. The systematic coding framework [6] was explored in order to improve the quality of corrupted images. Systematic coding paradigm was explored in [7], [8] and [9] with Reed-Solomon Slepian-Wolf codec and hybrid video codec The distributed video coding explored in [10], [11], [12] and [13] differ from the systematic coding scheme that is used for error resilience while streaming video in warless ad hoc networks. In the video encodings Wyner-Ziv codec was integral part and that was necessary for coding efficiency. On the other hand the systematic source-channel coding scheme also makes use of that codec for error – resilience. In the process video compression was employed for systematic transmission. In this paper we implement the SLEP proposed by Zhu et al. [1].

III. PROPOSED SYSTEM

Wireless ad hoc networks became ubiquitous in the real world. As they can be established with ease, it became handy to build such networks in case of emergencies when common communication networks are not available. The wireless channels working in such networks lack required bandwidth in general. However, due to the advent of new technologies in electronics, bandwidth of such network was dramatically increased. Now the wireless ad hoc networks are able to support live video streaming conveniently. However when compared with their wired counterparts they are far from outstanding. However, they can be leveraged to provide required quality. Quality streaming is essential as live video streaming is the content that is inelastic and delay-sensitive. Towards this end a reliable and robust scheme is required to ensure that video streaming takes place with considerable quality and accuracy. Towards this end many techniques came into existence as explored in the previous section. In this paper we implement the technique known as SLEP [18] that provides mechanism which can safeguard video transmission without loss in data. The SLEP approach provides reliable mechanism that can consider both PLR and PSNR to gauge the quality and accuracy of video transmission in the wireless channel. Since the ad hoc network has no fixed infrastructure, the inherent limitations of the channel are to be overcome. Towards this end, the technique takes care of error estimation and also possible steps to ensure reasonable quality besides accuracy of the video being streamed. The video streaming process is applied with SLEP approach that monitors and takes necessary steps that video streaming over wireless ad hoc networks is carried out with sufficient quality. The implementation of SLEP system is as shown in Figure 2.

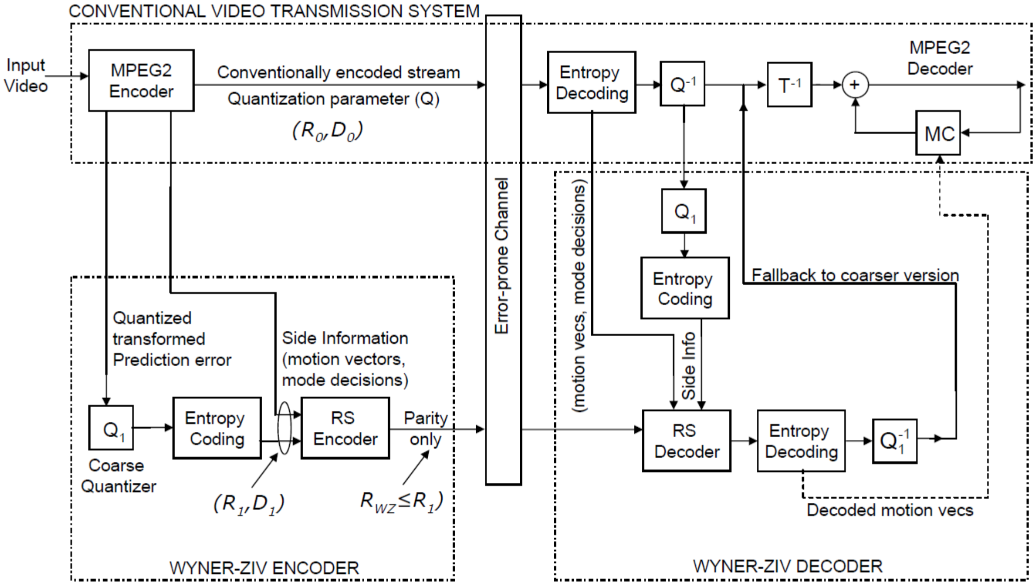

Figure 2 – SLEP implementation [18]

As can be seen in Figure 2, it is evident that the input video is given to MPEG2 encoder. Before transmitting video over error prone channel, it is subjected to Wyner-Ziv encoder. The result of this is sent to the Wyner-Ziv decoder. As the broadcasting is used in the network, there is the concept of channel sharing. This needs to be handled effectively in order to ensure systematic approach in video transmission. Selecting best video description has its role to play in the successful completion of video steaming. The PLR and PSNR are considered with certain probability. In order to evaluate the scheme, simulated study has been made with a prototype application that demonstrated the proof of concept. More technical details of the scheme can be found in [18].

IV. EXPERIMENTAL RESULTS

We have made experiments though our prototype application. The experiments are made in terms of distance vs. PLR, PLR vs. PSNR and so on.

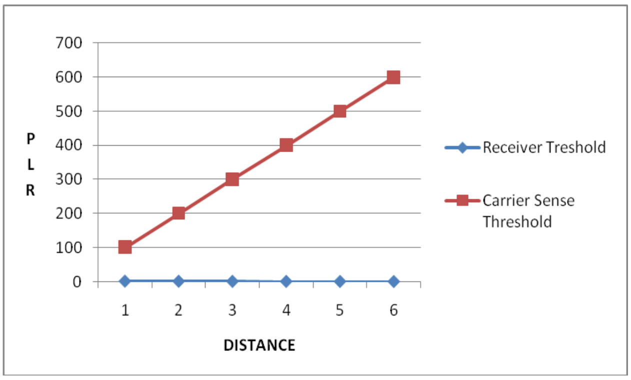

Figure 1 – Packet loss ratio versus distance

As can be seen in Figure 1, it is evident that the horizontal axis represents distance while the vertical axis represents packet loss ratio. From the results, it is understood that the receiver threshold and carrier sense threshold show increased PLR when distance is increased.

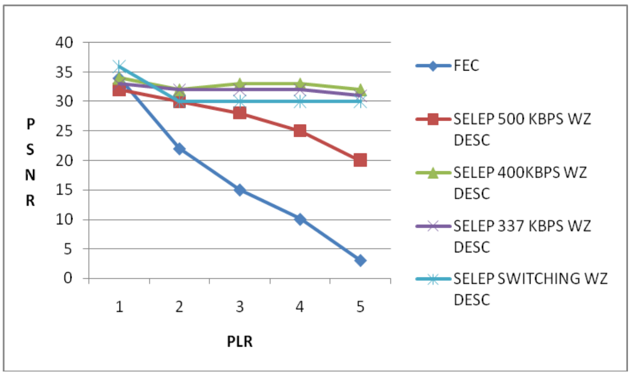

Figure 2 – PSNR of decoded video versus PLR

As can be seen in Figure 2, it is evident that the horizontal axis represents packet loss ratio while the vertical axis represents PSNR of decoded video. The results reveal that PSNR and PLR have relationship and if PSNR decreases PLR also decrease.

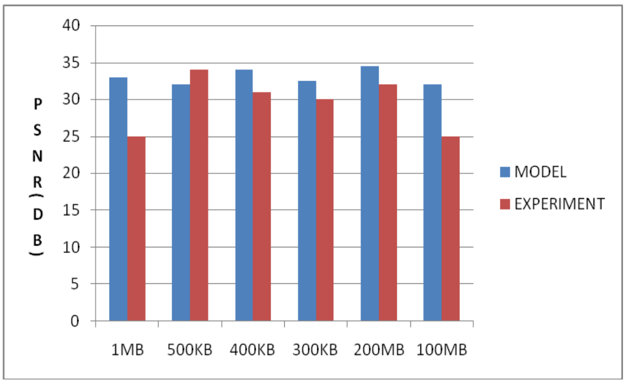

Figure 3 – Estimated versus observed PSNR of decoded video at different bandwidths

As can be seen in Figure 3, it is evident that the estimated and actual PSNR values were plotted. The horizontal axis represents bandwidth while the vertical axis represents PSNR values for decoded video. The results reveal that the experimental values are lesser than that of estimated values. The packet loss ratio is set at 4.0%.

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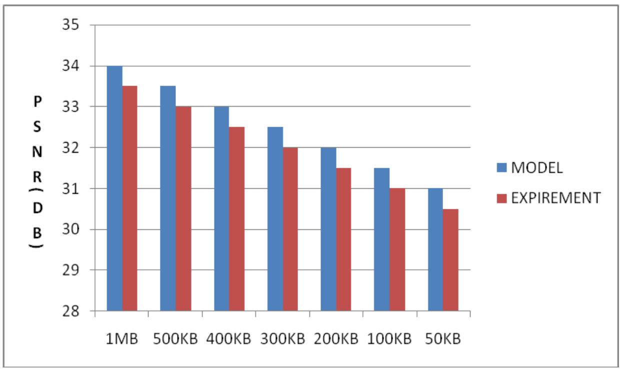

Figure 4 – Estimated versus observed PSNR of decoded video at different bandwidths

As can be seen in Figure 3, it is evident that the estimated and actual PSNR values were plotted. The horizontal axis represents bandwidth while the vertical axis represents PSNR values for decoded video. The results reveal that the experimental values are lesser than that of estimated values. The packet loss ratio is set at 8.0%.

V. CONCLUSIONS AND FUTURE WORK

In this paper we studied the concept of systematic lossy error protection for video transmission over wireless ad hoc networks. Due to the innovative technologies in electronics, wireless ad hoc networks have higher capabilities now. Such networks are also used for video transmission. However, it is very challenging to achieve error-resilient video transmission in such networks. In this paper the SLEP technique is implemented in order to achieve this. The video signals transmitted have to parts. The first part reflects systematic portion while the second part reflects error protection information. Using a video distortion model the PLR and PSNR are computed and the experiments are made on them with a prototype application. The results reveal that the proposed approach is better than existing ones. However, the estimated values and experimented values differ. The experimented values for PSNR at various bandwidths are less than that of expected values. This research can be extended further to adapt to other wireless networks.

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