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ADAPTIVE FEC WITH DYNAMICALLY BLOCK SIZE CONTROL FOR VIDEO STREAMING OVER WIRELESS NETWORK

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ABSTRACT

Video streaming over wireless network is a challenging task due to high packet loss rate, burst packet loss, and low available bandwidth problems. In this paper, we propose a scheme using Adaptive Forward Error Correction (AFEC) with block size control for video streaming over wireless network. Our scheme calculate the block size by referring the amount of packet loss, if the amount of packet loss is large, we calculate the block size that will be used in next time, then resize the block size.

Keyword: forward error correction, FEC, wireless network

1. INTRODUCTION

With the Internet grows, wireless communication has become more and more popular after the upgrades of transmission rate and transmission volume, which is attracting more network researchers in the research of high-quality video transmission. Meanwhile, more and more users choose to connect to Internet services with mobile devices, like Tablets PCs and Smartphones. Therefore, it is important to develop an efficient video encoding/decoding method, such as MPEG-4 for mobile computing environment. The invention of MPEG-4 has made video streaming transmission become easier, which is the first video streaming protocol that includes network abstraction layer. The transmission of immediate streaming video has become better due to MPEG-4's good network adaptability and its great fault tolerance on packet loses. However, there are still some unsolved problems such as packet loss and burst packet error. These problems brake the frame, and sometimes even break the threshold of fault tolerance on MPEG-4, which lowers the quality of video streaming until next Group of Picture (GOP). Automatic Retransmission Request (ARQ) and Forward Error Correction (FEC) are two commonly used algorithms for packet error/loss control. Compared to ARQ, FEC is more suitable for live streaming video because of its shorter transmission delay time and better transmission reliability due to its redundancy packet. Thus, many researchers proposed various FEC mechanisms which are according to different network environments, such as packet loss rate or network bandwidth to adjust amount of redundancy packets. Those FEC mechanisms discussed how many sources and how many redundant packets are needed in various kind of network environment without considering the impact of packet size.

However, transmission packet size not only affects packet amount and may lead video delay in video streaming, but also affects video quality when packet loss.

Smaller packet size would lose more packets than larger packet size under the same packet loss rate. Losing more packets will more likely affect different frames separately and result in lower to be decodable frame rate. In other words, the size of a packet needs to be as large as possible when video is transmitted without FEC [1]. A redundant packet is encoded from a video source that can only recover the error/loss data in the same block, but cannot recover the error/loss data, which is in the other block. In paper [2], the research proves that small block's recoverable error rate is better than large block's recoverable error rate. In other words, FEC recoverable error rate is inversely proportional to block size [2].

In this paper, we study the effect of packet loss on the transmission quality of MPEG-4 with FEC over wireless networks. We not only consider the impacts of packet loss under various distribution, but also study the impact of burst packet loss, which would affect the video transmission quality. So we propose a new scheme called Adaptive Forward Error Correction with dynamically block size control (AFEBC). AFEBC adjusted the transmission block size according to the communication status in wireless network, which reduced the impact on video quality.

2. METHODOLOGY

In most of the FEC research, they try to find out how to increase the recovery rate by adjust bandwidth, or adjust the packet size. In this paper, we adjust the block size to decrease the error rate in time.

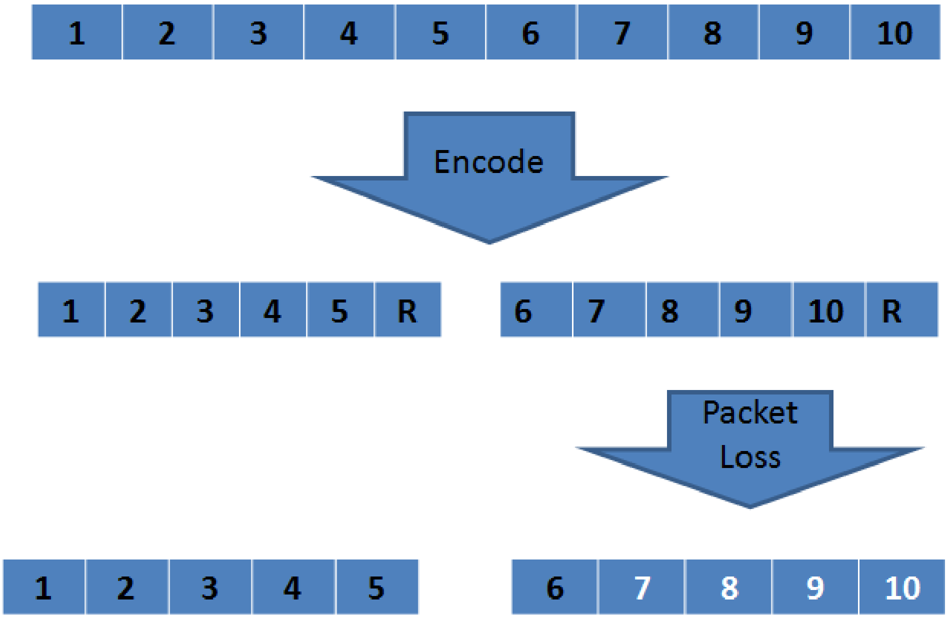

Figure 1.The original FEC mechanism

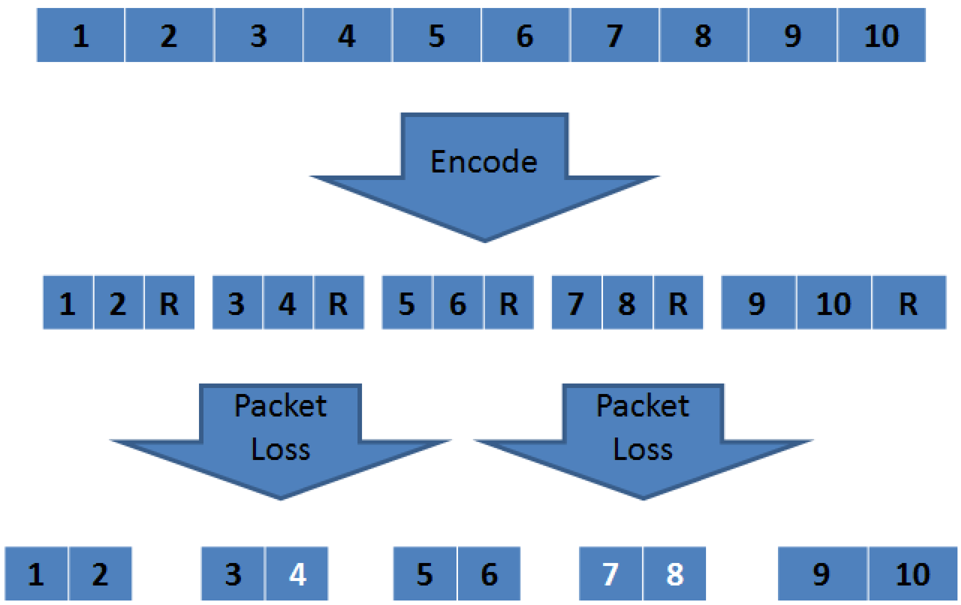

Figure 2.The dynamically adjust mechanism

Figure 1 shows how the original FEC mechanism works. The original FEC mechanism will divide the streaming video source into blocks, and cut the block into packets. Then the FEC will fill a redundant packet into each packet. When video data is lost in streaming, the loss data can be recovered by using redundant packet. But the loss data cannot be always recovered by the original FEC mechanism under various situations. Hence, we design a mechanism, which is shown in figure 2, can dynamically adjust the block size to recover the loss data more efficiently.

The proposed FEC mechanism can adjust the block size dynamically when the packet loss rate getting higher or lower immediately. So that the recovery rate can be maintained under various network environment.

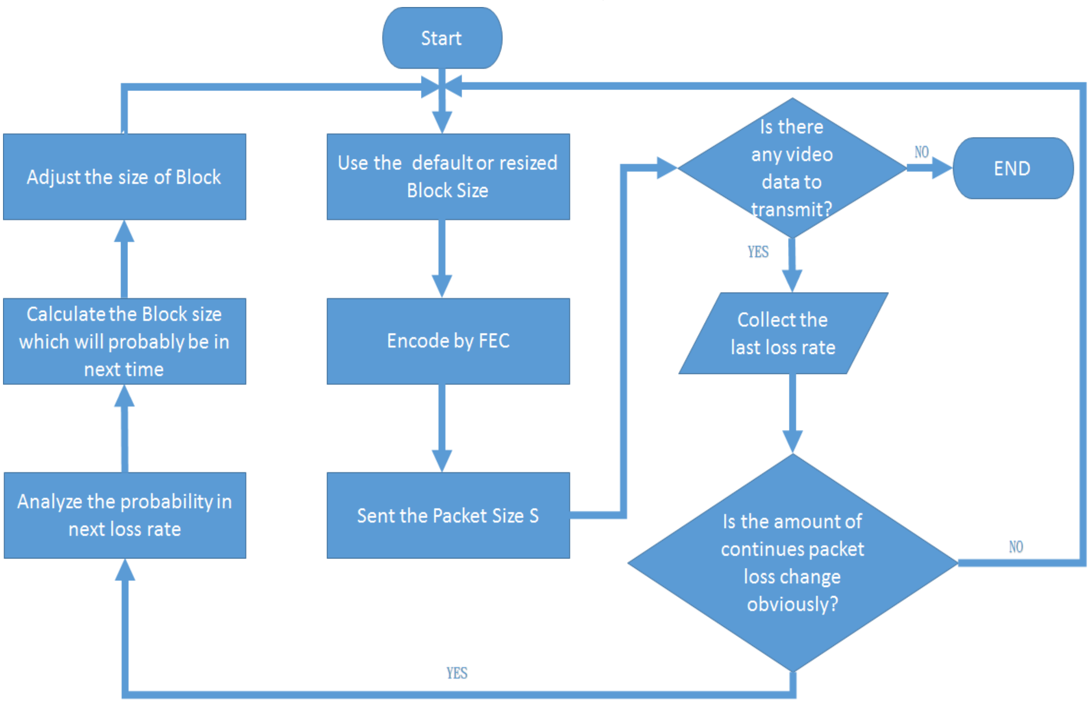

Figure 3. Dynamically adjust the block size flowchart

Figure 3 shows the flowchart of our mechanism in this paper. At first step, we use the default/resize block size to encode and transmit. If there is no more video stream to transmit, then finish this mechanism. If there are more video data to be transmitted, then collect the last loss rate, and analyze whether the amount of successive packet loss change obviously or not. If not, return to first step. Otherwise, the proper block size that will be used in next time is calculated by the probability of packet loss under Gilbert–Elliott model [3] and weighted values. While the suggested block size is updated, the mechanism adjusts the block size and use the resize block to transmit.

$$E_{CPLR-N} = (1\text{-}\alpha) \times E_{CPLR-O} + \alpha \times E_{CPLR-C} \quad (1)$$

$$B_N = E_{CPLR-N} \times \left(\frac{B_O}{E_{CPLR-O}} + \frac{B_C}{E_{CPLR-C}}\right) \quad (2)$$

E_{CPLR-O}: error rate in last time
E_{CPLR-C}: error rate in this time
E_{CPLR-N}: error rate in next time
B_O: block size in last time
B_C: block size in this time
B_N: block size in next time
α: weight value

In equation 1 we use weighted value, the error rate in last time, and the error rate in this time to calculate the error rate in next time. By using heuristic approach, the weighted value α is set to 0.53 to obtain better result. Equation 2 shows the detailed calculation of the block size that would be used in next time.

3. SIMULATION

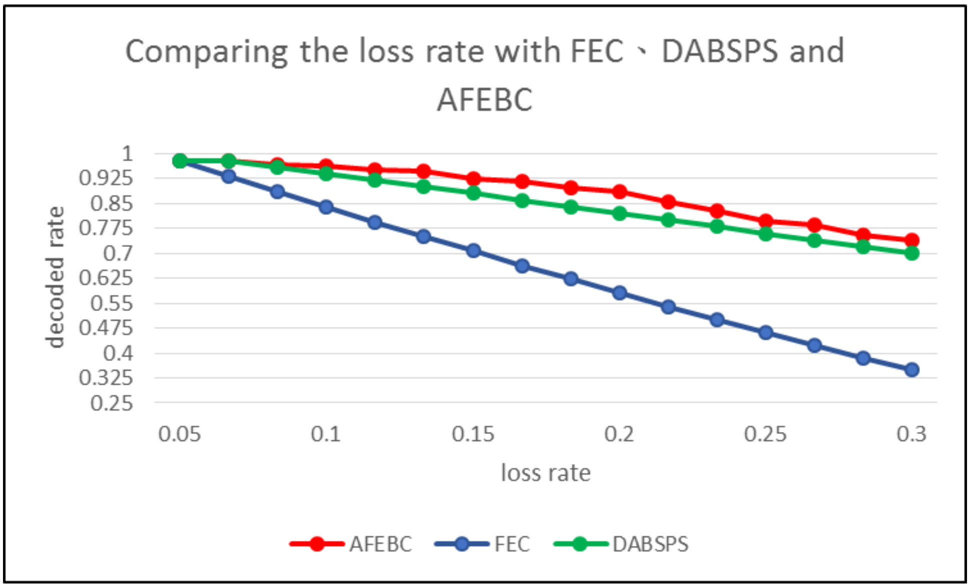

Figure 4. Comparing the loss rate with FEC, DABSPS, and AFEBC

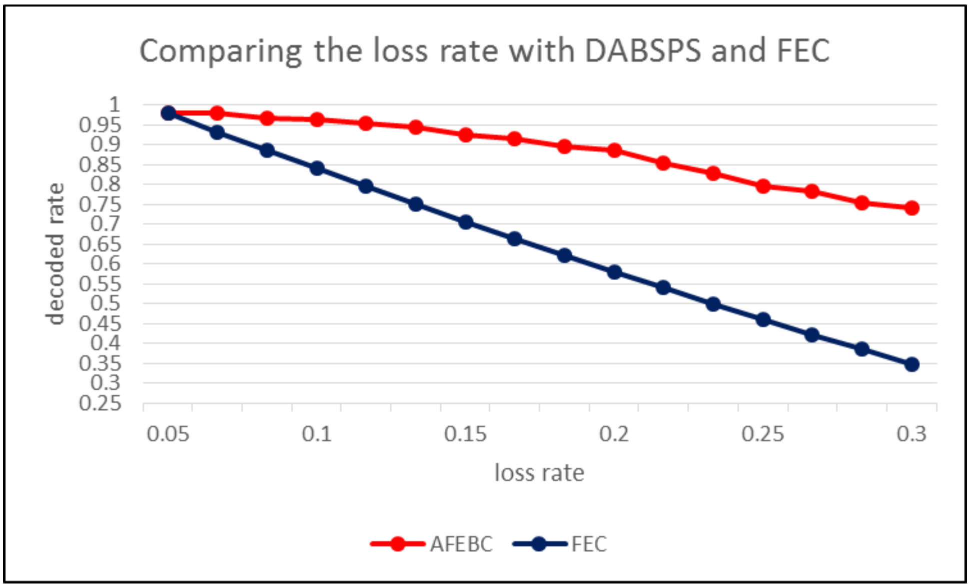

Figure 5. Comparing the loss rate with DABSPS and FEC

In this section, we compare the results of our mechanism between the original FEC and DABSPS [5]. Figure 4 and figure 5 show that our mechanism has higher decoded rate than that of FEC and DABSPS. In other words, our mechanism can recover more loss data than two other mechanisms. The result of DABSPS is closer to our mechanism and FEC has no mechanism to conquer the increasing error rate. So FEC's recovery rate keeps decreasing. Instead, AFEBC has an adaptive mechanism too, so we can find that our mechanism and DABSPS have similar result.

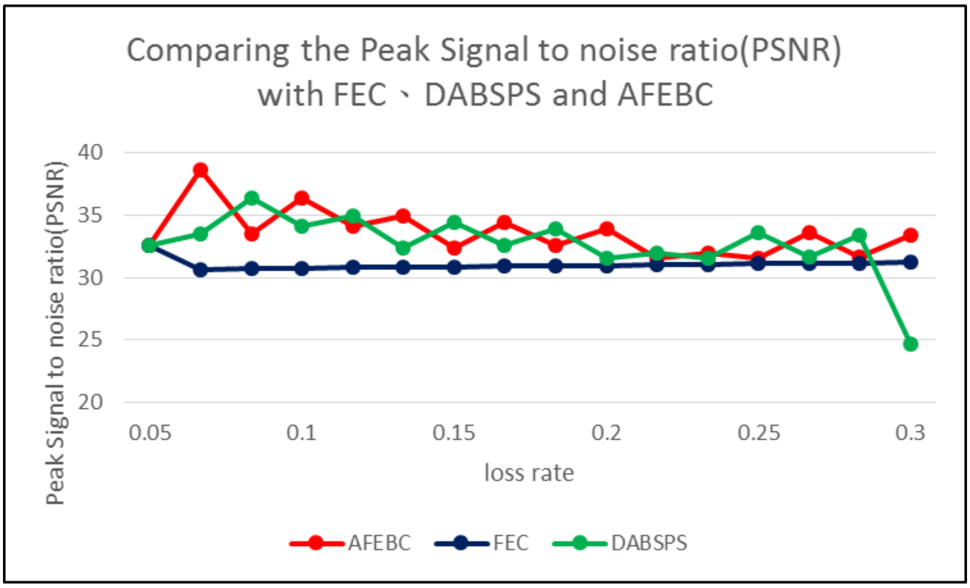

Figure 6. Comparing the Peak Signal to Noise Ratio (PSNR) with FEC, DABSPS, and AFEBC

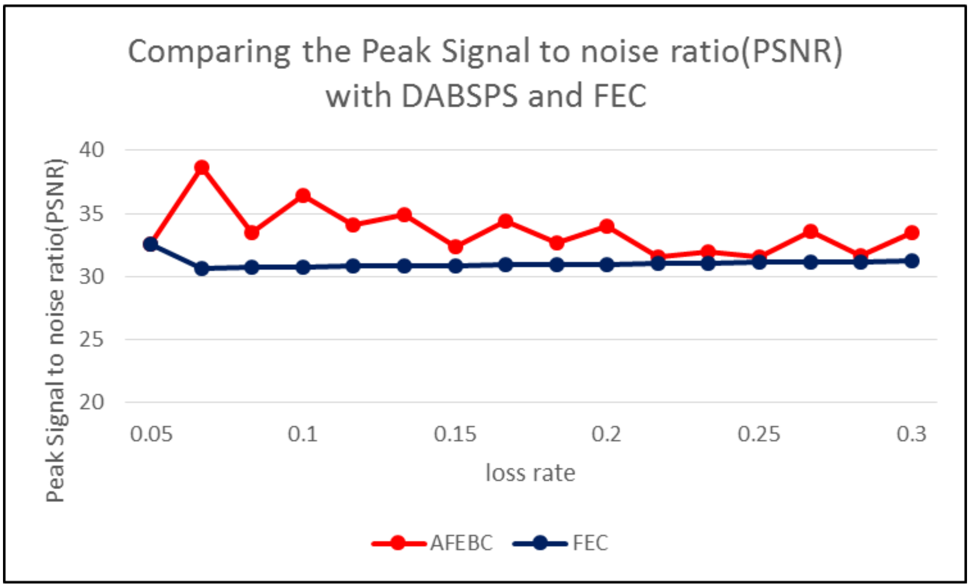

Figure 7. Comparing the Peak Signal to Noise Ratio (PSNR) with DABSPS and FEC

Figure 6 and figure 7 show that the quality of video by comparing AFEBC, FEC, and DABSPS. We can see that the DABSPS in loss rate 0.3 has obviously low PSNR. FEC has lowest PSNR, because FEC cannot adjust dynamically when stream changes. And AFEBC keeps a better quality.

4. CONCLUSION

In this paper we design a new mechanism to reduce packet loss rate. We conducted the simulation by NS2 and found that AFEBC has higher recovery rate than that of FEC and DABSPS.

In this paper AFEBC mechanism can adjust block size dynamically. If the loss rate increased, the AFEBC will change block size to be smaller one; if the loss rate decreased, the AFEBC will change block size to bigger one. When video streaming is in a better condition, the AFEBC can release more resources.

By resize the Block size, the packet loss can be controlled within an acceptable range. If the successive packet loss rate is large, then the block size will became smaller in next time. This can protect the video's quality in a stable status.

Although the AFEBC can work better than the original FEC, the improvement of AFEBC comparing to DABSPS is not significant. Therefore, we will enhance the results of the proposed mechanism in the future.

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