Packet Loss Recovery for Streaming Video

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1 Summary

This paper deals with packet loss problem in unicast streaming of MPEG video, where the interdependence between I, P and B-frames causes propagation of errors. **First**, experiments show that the more packet loss is, the lower value of video quality (in PSNR) is. An increase in the packet loss rate reduces the frame rate significantly. **Second**, the relationship between frame rate f and packet loss rate is modeled as $f = f_o(1-\Phi)$, in which, f_0 is the original frame rate and $\Phi = \Sigma_i P(f_i)P(\overline{F}/f_i)$ is the fraction of frame dropped (where i is type I, P or B; $\overline{F}$ and f_i are the event that a frame is useless, and that a frame is of type i). $P(\overline{F}/f_i)$ is computed with each i, assuming if any packet is lost, the frame is useless. This model matches the experimental results closely. The benefits of selective reliability were proved: recovering an I or P-frame increases the frame rate significantly, but recovering an B-frames does not. **Third**, the paper proposed an architecture for unicast streaming of MPEG-4 with selective retransmission and bandwidth adaptation. SR-RTP extends RTP to support ALF (each frame corresponds to one ADU) and selective retransmission. By including ADU sequence number, ADU offset, and ADU length, it can detect all cases of packet loss (mid-frame, start-of-frame, end-of-frame, complete frame loss). The field ADU priority helps selectively retransmit data, with the highest priority for I-frame, and the lower for P-frame if it is farther to the previous I-frame. Implemented SR-RTP library is independent with RTSP library and backwards-compatible with RTP. It can interoperate with Congestion Manager for bandwidth adaptation. **Next**, the paper proposed a postprocessing method to conceal I-frame packet loss. It uses the motion vectors from the preceding P to B-frame for the corresponding macroblock and adjust this value to reconstruct data in the I-frame. If the relevant motion information is lost, spatial technique is used to estimate the averaging of motion vectors from surrounding macroblock. **Finally**, experiments show the advantages of this system on selective reliability and receiver postprocessing approach under various network condition.

2 Comments

One obvious drawback of SR-RTP is that when the whole frame is lost, the type of this frame is unknown. Thus, if the whole I-frame is lost, this frame will not be requested to retransmit. But, because the I-frame's size is large, the probability for this event is small. However, one possible complete solution for this case is that the receiver can base on the IBP pattern to reason the type of the lost frame. Second, the paper does not specify the condition to decide whether retransmission the loss packet is better or recovering it is better. Third, I do not quite agree with the formular (4) and (6). In my opinion, it should be :

$$P(\overline{F}/B) = 1 - \frac{1}{N_p - 1}\sum_{k=1}^{N_p}(1-p)^{S_I+(k+1)S_P+S_B}$$

This paper creates an improvement with its analytic model. The idea of just selectively retransmitting the important data to utilize network resources is excellent. Also based on the dependence of frames, the idea of recovery techniques using the available data to infer the lost information is interesting. With this method, no redundant data need to be encoded to recover the lost information. In general, this is a successful study with many achievements.