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A Rate Control Scheme of the Even Low Bit-rate Video Encoder

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Rate control plays an important role in transmitting low-delay and high-quality images over the channel of very low bandwidth. The rate control algorithm in MPEG-4 or H.26X only defined the rate control model of P-frame, and did not introduce the rate control model of I-frame as it supposed that only the first frame is an I-frame, the others are all P-frames. However, in practical applications, a certain number of I-frames have to be inserted to meet the demand for fault-tolerant transmission and information retrieval. Oriented toward the application demand of remote surveillance system based on PSTN, a rate control strategy is proposed for encoding video at even low bit-rate in this paper. The strategy includes a rate-control algorithm for I-frame and introduces a quadratic rate distortion model, which solves the problem of the rate control used at very low bit-rate preferably. The rate distortion model of I-frame is designed referring to that of P-frame. It mainly involves three processes: initial quantization parameter calculation, objective bit number allocation, and objective quantization parameter calculation.

TM5 of MPEG-2 proposed the target bit-number allocation model of I, P, and B frame, but the algorithm for the model is a bit complex. Based on the quadratic rate distortion model, a novel algorithm for the target bit-number allocation is presented in this paper.

In order to keep the stability of image quality, VM8 limits the change range of the new quantization parameter from -0.25 to 0.25 times of the previous frame. As a result, if the previous frame's quantization parameter is small but the current frame's quantization parameter is calculated to be large, the current frame's quantization parameter should have been corrected with a small value, which will cause excessive coding bits, and worsen the transmission delay. In this paper, we present a correction algorithm for the computation of P-frame's quantization parameter.

The results of experiments show that the proposed scheme reduces the delay of encoder buffering greatly, and improves the quality of reconstructed images clearly at the same time. In terms of the system's transmission delay, our scheme uses reasonable algorithms for computing the quantization parameters of I-frame and P-frame, and adjusting the GOP length dynamically. The transmission delays are significantly decreased and the buffer overflows are avoided. In terms of the reconstructed image quality, the test sequence's PSNRs with our scheme are higher than VM8's at all the bit rates, and the coded bit-number of our scheme is less than VM8's at the same bit rate. In terms of the deviation of output bit-streams, the average deviation of our algorithm is much less than VM8's. The less the deviation of the output bit-stream is, the more appropriate it is to be transmitted at the given bandwidth, and the less the transmission delay is.

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