Objective Video Quality Measurement Using Embedded VQMs

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***Abstract*— Video quality monitoring has become an important issue as multimedia data is increasingly being transmitted over the internet and wireless channels where transmission errors can frequently occur. Although no-reference models are suitable to such applications, current no-reference methods do not provide acceptable performance. In this paper, we propose an objective video quality assessment method using embedded video quality metrics (VQMs). In the proposed method, the video quality of encoded video data is computed at the transmitter during the encoding process. The computed VQMs are embedded in the compressed data. If there are no transmission errors, the video quality at the receiver would be identical with that of the transmitting side. If there are transmission errors, the receiver adjusts the embedded VQMs by taking into account the effects of transmission errors. The proposed method is fast and provides good performance.**

Keywords—video quality assessment; quality monitoring; no-reference; embedded VQM

I. Introduction

In this paper, we propose an objective video quality measurement method with embedded VQMs. In digital video transmissions, the video quality at the receiver should be identical to that at the transmitter if there is no transmission. In the proposed method, the video quality metrics (VQMs) of the compressed video data are computed at the transmitter during the encoding process and the VQMs are embedded in the compressed video data. Since only a few bytes are needed for each second, the additional data increase is negligible. Finally, the receiver computes the video quality of the received video signals by using the VQMs and transmission error information.

II. Proposed Method

Fig. 1 is a block diagram of the proposed method. After the source video sequence is encoded, the video quality of the compressed video data is computed. Since the source video sequence was available, we used an FR method. The VQM were computed for every second and a single byte would be sufficient to represent a VQM. Thus, these VQMs can be easily embedded as metadata in the present video codec standards.

Generally, the decoder produces a processed video sequence. The bit-stream analyzer examines the bit-stream data and extracts codec parameters, bit rates, frame rates, and transmission error information. If there are no transmission errors, the video quality at the receiver is identical to that of the transmitter. If there are transmission errors, the degradations due to the transmission errors are estimated and the corresponding VQM values have to be reduced.

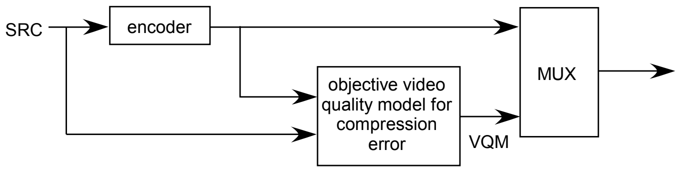

Fig. 1. Embedding VQMs at the transmitter.

The VQM already reflects all the effects of codec parameters, bit rates, frame rates. Thus, adjusting the VQMs at the receiver only needs to reflect the effects of transmission errors. Some degradations due to transmission errors include freeze frames, mono-color blocks (e.g., green blocks), error areas, etc.

Fig. 2 shows an example of frames with error areas and erroneous green blocks. In the proposed method, we obtained the freeze information from the processed video sequence. From the bit-stream data, we estimated the error areas due to transmissions. Then, we used neural networks to adjust the VQMs when transmission errors occurred. The inputs to the neural networks include embedded VQMs, the number of freeze frames, and the average error area. Fig. 3 shows the neural network with the inputs.

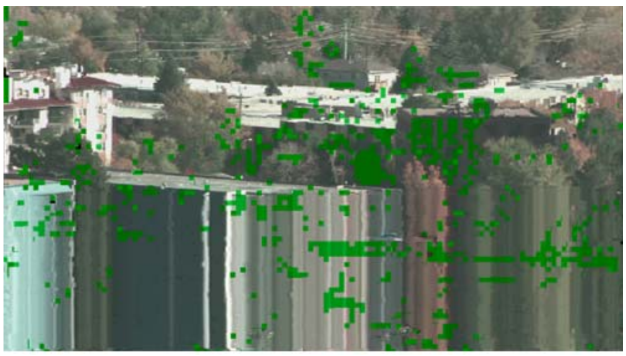

Fig. 2. Impaired frame with erroneous regions and mono-color blocks.

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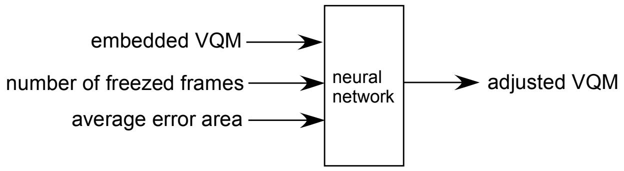

Fig. 3. Input to the neural network.

III. EXPERIMENTAL RESULTS

Two subjective experiments using HD video sequences were conducted to evaluate the performance of the proposed method in accordance with ITU-T Recommendation P.910 [1]. The test conditions include various bitrates, various sizes of GOP (group of pictures), various packet loss ratios, and error types (slicing, freezing). Table 1 summarizes the test conditions of the two subjective tests. HD source video sequences were chosen by considering their spatial and temporal complexity values.

After we generated the PVSs (processed video sequences) using the source sequences and the test conditions, we performed subjective tests. In each subjective test, 24 evaluators participated and screening was applied to eliminate those evaluators whose subjective scores were significantly different from those of the others. In the screening procedure, if the correlation coefficient of an evaluator's subjective scores with those of the others was smaller than 0.75, the evaluator was replaced with a new evaluator.

Table 1. Test conditions.

bit rates (Mbps)	30, 14, 13, 11, 9, 7, 6, 5, 3.5, 3, 2, 1
GOP	30, 45, 60
packet loss ratio	0.1, 0.2, 0.45, 0.5, 0.6, 0.8, 0.9 , 1.2,
concealment	slicing, freezing
transmission error types	random, burst

Figs. 4-5 show the performance of the proposed method and EPSNR [1]. The EPSNR method did not separately consider impairments due to transmission errors such as freezing or slicing errors. The proposed method produced high correlations with subjective tests: 0.92 for the first test and 0.87 for the second test. On the other hand, the correlation coefficients of the EPSNR method showed rather poor performance since it did not consider transmission errors.

The proposed method may be viewed as an NR model, which does not use any information about the corresponding source video sequence. The data size of the embedded VQMs is very small compared with the compressed video data. The proposed method is very fast and can be easily implemented. During the encoding process, the VQMs can be computed and attached to the compressed video data as metadata.

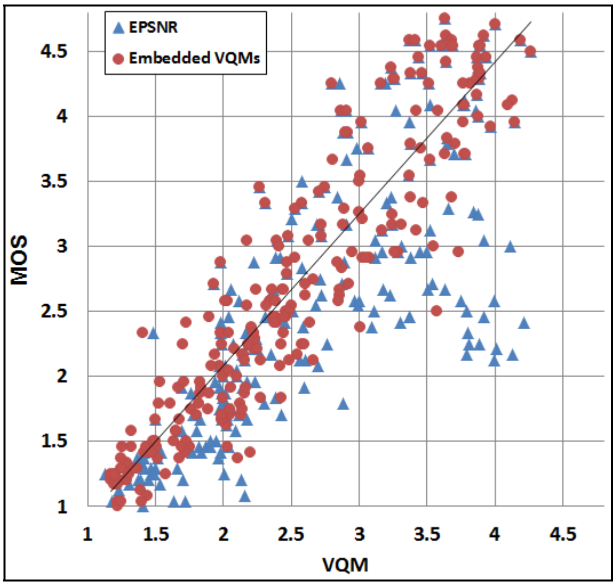

Fig. 4. Scatter plots of the proposed method with embedded VQMs (cor=0.92, red circles) and EPSNR (cor=0.79, blue triangles).

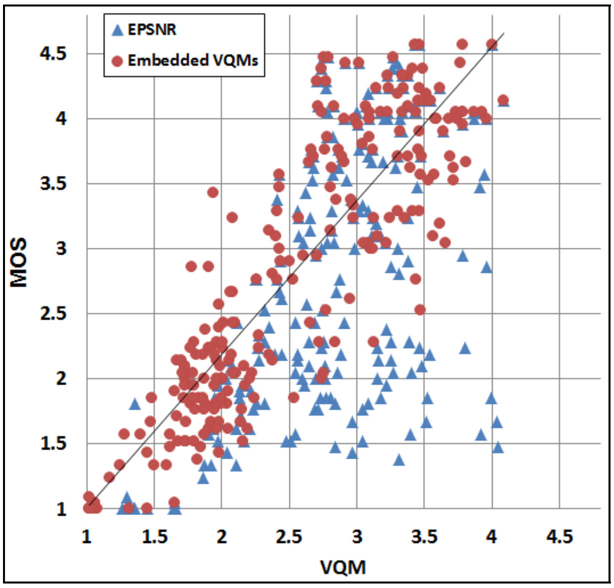

Fig. 5. Scatter plots of the proposed method with embedded VQMs (cor=0.87, red circles) and EPSNR (cor=0.54, blue triangles).

REFERENCES

[1] ITU-T Recommendation P.910, "Subjective Video Quality Assessment Methods for Multimedia," 1999.

[2] C. Lee, S. Lee, J. Lee, K. Lee, H. Choi, G. Seo and J. Park, "Video Quality Measurement Method for Multimedia Applications Using reduced-reference signals," SPIE Optical Engineering., vol. 50, no. 6, 067403, June 201.