Multi Frame Super-Resolution for Versatile Video Coding

Toshiya Hori, Remina Yano, Hiroshi Watanabe
Waseda University
3-14-9 Okubo, Shinjuku-ku, Tokyo, Japan
tsy-h@fuji.waseda.jp

Takeshi Chujoh, Tomohiro Ikai
Eiichi Sasaki, Takuya Suzuki, Norio Ito
Sharp Corporation
1-9-2, Nakase, Mihama-ku, Chiba, Japan
chujoh.takeshi@sharp.co.jp

***Abstract*— The latest video coding standard, Versatile Video Coding (VVC), has been finalized in July 2020. In traditional codecs, it is not possible to refer to different resolution pictures in inter-picture prediction except for inter layer cases. However, VVC does support Reference Picture Resampling (RPR), which allows pictures to refer to different resolution pictures so that video resolution can be adaptively switched in sequence. This work's objective is to improve compression efficiency in the case of RPR. In the preliminary experiments, the compression efficiencies of reduced size encoded case where frames are encoded in half size and up-scaled to their original size and original size encoded case are compared. The result shows that most sequences get worse BD-rate when the sequences are encoded/decoded in reduced size. However, up-scaling is done by VVC Test Model, VTM-10.0, which uses a linear interpolation filter. Thus, the frames cannot recover high-frequency components sufficiently and cannot use temporal correlation. Therefore, this paper proposes a multi-frame super-resolution between frames of different resolutions where some frames are encoded in high-quality frames in their original size and other frames in half size by using RPR. The proposed method uses the original size frames, which contain a lot of information, to super-resolution the reduced frame. By doing so, it saves the bitrate and increases the quality of reduced frames.**

Keywords—Multi frame super-resolution; Versatile Video Coding; Reference Picture Resampling

I. Introduction

Recently, many super-resolution and quality improvement methods have been invented. Among them, MFQE [1] proposes to use multi-frames to enhance the compressed video quality. It detects peak quality frames (PQFs) in video and enhances the quality of non-PQFs by using PQFs. We extend this technique to super-resolution between different resolutions.

II. Experimental Data and Proposed Method

We use the VVC [2] Test Model, VTM-10.0, random access mode and sequences of Common Test Condition (CTC) [3]. We compare the compression efficiencies of the next three cases. Case 1 is encoded in normal size. Case 2 is encoded in half the size. Case 3, as shown in Fig. 1, the PQF remains the original size, the non-PQF is reduced to half the size. Then, in Case 2 and 3, the decoded video is restored to its original size using MFQE. Fig. 2 shows the BD-curves of each Case for two 4K resolution sequences. Coding efficiency improved in Case 2 at very low bitrates and in Case 3 at low bitrates. By combining Case 2 and 3, Class A1 and A2, which consist of 4K resolution sequences, obtained an average BD-gain of 4.47% compared to Case 1. From the results, by using RPR and using original size frame information, we can improve coding efficiency for Class A1 and A2.

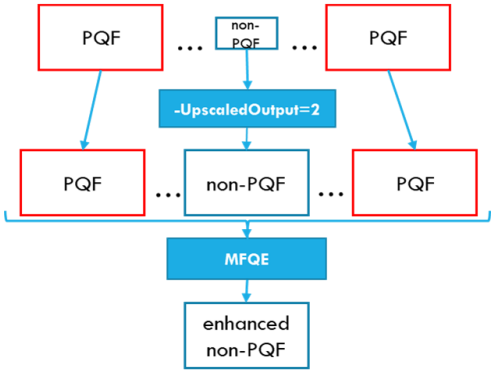

Fig 1. Transmission system combining RPR and MFQE.

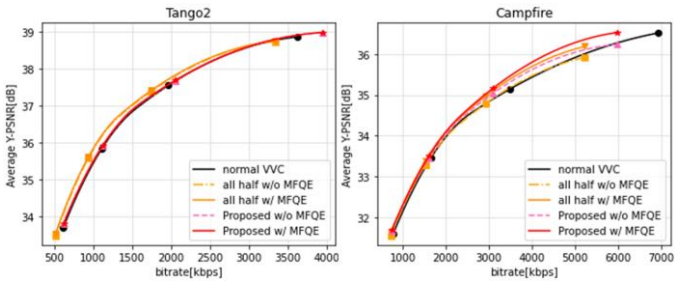

Fig 2. BD-curves of three case for 4K resolution sequences.

References

[1] Z. Guan, Q. Xing, M. Xu, R. Yang, T. Liu and Z. Wang, "MFQE 2.0: A new approach for multi-frame quality enhancement on compressed video," IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), pp. 1-1, 2019

[2] ITU-T Recommendation H.266 Versatile video coding, Aug. 2020.

[3] F. Bossen, J. Boyce, K. Sühring, X. Li and V. Seregin, "JVET common test conditions and software reference configurations for SDR video", Joint Video Experts Team Document, JVET-N1010, Geneva, 2019