Two-Step Coding For High Definition Video Compression

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High definition (HD) video has come into people's life from movie theaters to HDTV. However, the compression of HD videos is a challenging problem due to flicker noise, caused by film grain. The flicker noise significantly limits the applicability of motion estimation (ME), which is a key factor of the efficient video compression in block-based coding standards. Due to the flicker noise, it is difficult to obtain a perfect match between a current block and a reference block. Consequently, we suggest to first denoise the HD pictures by averaging, generating downsampled pictures called DC frames, on which ME becomes very efficient. The proposed Two-Step Coding (TSC) encodes the HD frames in intra mode; then generates the DC frames with the DC coefficients of DCT and compresses them with inter-frame techniques.

Suppose we DCT encode a 4×4 block $\{x_{ij} \ (i, j=0\sim3)\}$ in intra mode, $\text{DCT}(\{x_{ij}\}) = \{X_{mn} \ |m, n=0\sim3\}$, where $X_{0,0}$ is the DC coefficient. Unlike ordinary codecs simply coding all the 16 coefficients, TSC only codes the 15 AC coefficients in the first step, since we set $X_{0,0}=0$. The AC coefficients can be decoded into $\{x'_{ij}\}$, $\text{IDCT}(\{X_{mn}\}) = \{x'_{ij}\}$, where ($X_{0,0}=0$) and IDCT is the inverse DCT. The original $X_{0,0}$ is regarded as color values forming a DC frame, which is inter-frame coded in the second step. The decoder gets $X_{0,0}$ and x'_{ij} computed by the two steps and recovers the original picture as $x_{ij} = x'_{ij} + X_{0,0}$.

In essence, all TSC does is to re-encode the DC coefficients of the intra-frame coded HD frames with inter-frame techniques. Intra prediction is made available to improve the compression of intra-frame coding. The key benefit of TSC in comparison to the most popular standards, in particular, in comparison to H.264 lies in better utilization of inter-frame coding. Due to flicker noise, H.264 mostly employs intra block coding on HD videos. However, it is well-known that inter-frame coding significantly outperforms intra coding in video compression rate if the temporal correlation is correctly utilized. By downsampling each frame to DC frame, TSC makes it possible to apply inter-frame coding. We provide experimental data and analysis to illustrate this fact.

Index Terms—**High Definition Video, H.264, Film grain, flicker noise, SVC**

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