Temporal Wavelet Transform-Based Low-Complexity Perceptual Quality Enhancement of Compressed Video

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1. Contributions

1. We propose to **improve perceptual quality** by exclusively enhancing low-frequency content, which can exploit the limited computational resource more efficiently. This is the first attempt on addressing the problem of perceptual quality enhancement under computational complexity constraint from the perspective of temporal frequency.
2. We propose to implement the **Temporal Frequency Analysis (TFA)** and **Temporal Frequency Synthesis (TFS)** via **Temporal Wavelet Transform (TWT)** and **Temporal Wavelet Inverse Transform (TWIT)** with a **hand-crafted Motion Estimation (ME)** module. Furthermore, we design a TWT-based low-complexity compressed video perceptual quality enhancement method that can enhance multiple frames simultaneously.
3. We conduct extensive experiments to verify the effectiveness of the proposed method. Experimental results show that our method achieves comparable quality enhancement with **13× computational complexity reduction**.

2. Framework (*Proposed TWT-QE*)

Temporal Wavelet Transform
(Temporal forward\ backward Haar、CDF 5/3)
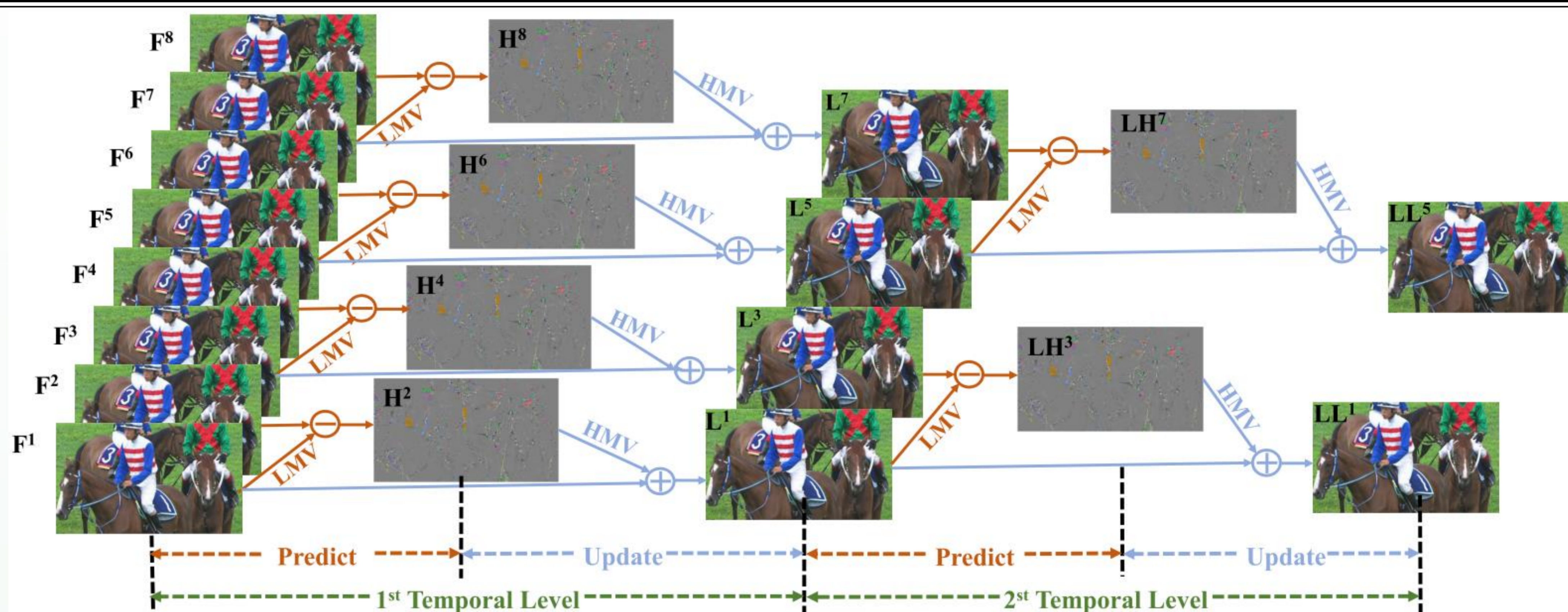
Overview of
TWT-QE
(Inference、Training)
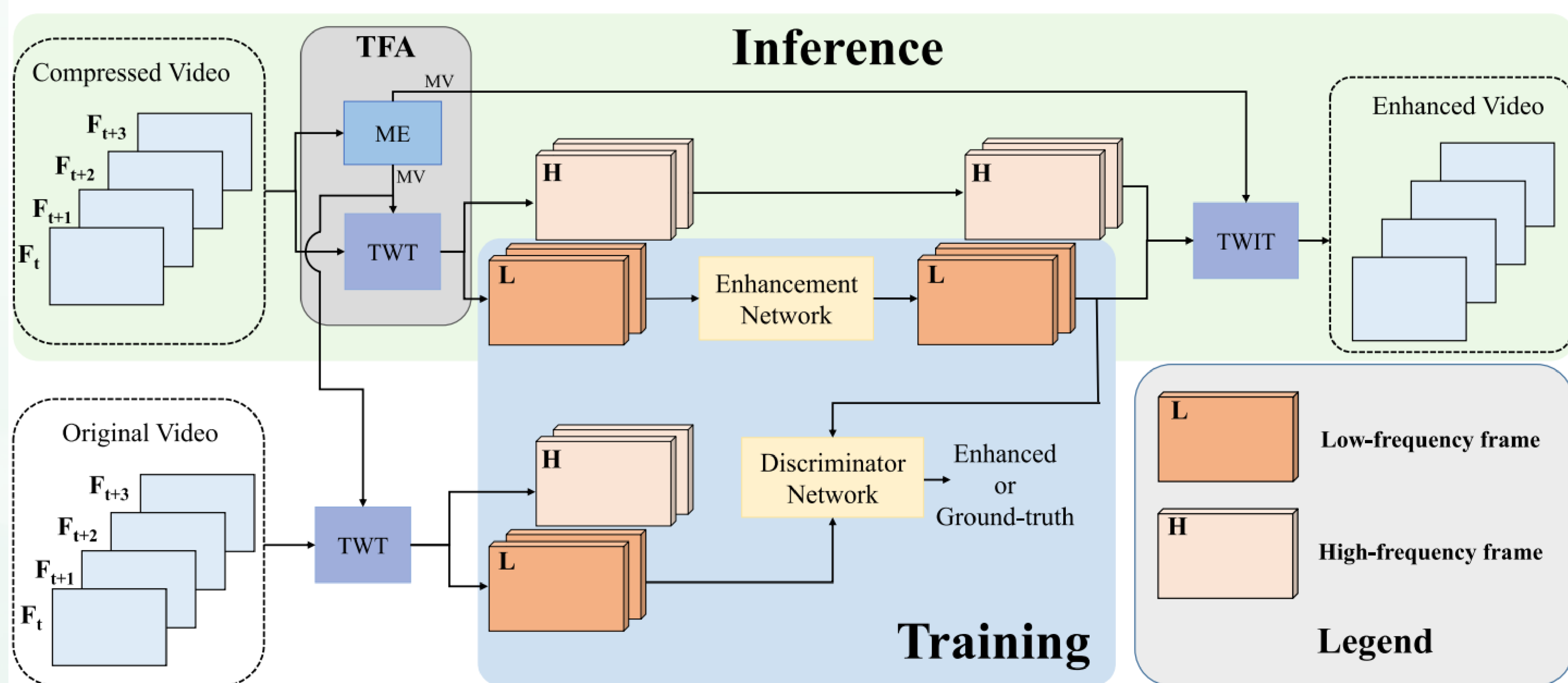
3. Experiment Results of *Proposed TWT-QE*

Comparison with SOTA Methods

Metric	Compressed	MW-GAN+	Ours
MOS	2.95	3.29	3.26
ΔLPIPS	-	-0.053	-0.064
ΔPI	-	-1.145	-1.380
FLOPs	-	4995.98G	109G

Influence of Different TWT Level

TWT Decomposed Level	0	1	2	3	4	5
ΔLPIPS	-0.069	-0.068	-0.070	-0.067	-0.064	-0.056
ΔMUSIQ [56]	5.54	4.63	4.24	4.00	3.47	3.19
ΔCLIP-IQA [57]	0.155	0.152	0.183	0.177	0.161	0.157
FLOPs	2812G	1429G	737G	392G	219G	132G

欢迎同行们的交流、探讨！

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