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Structure-Preserving Motion Estimation for Learned Video Compression

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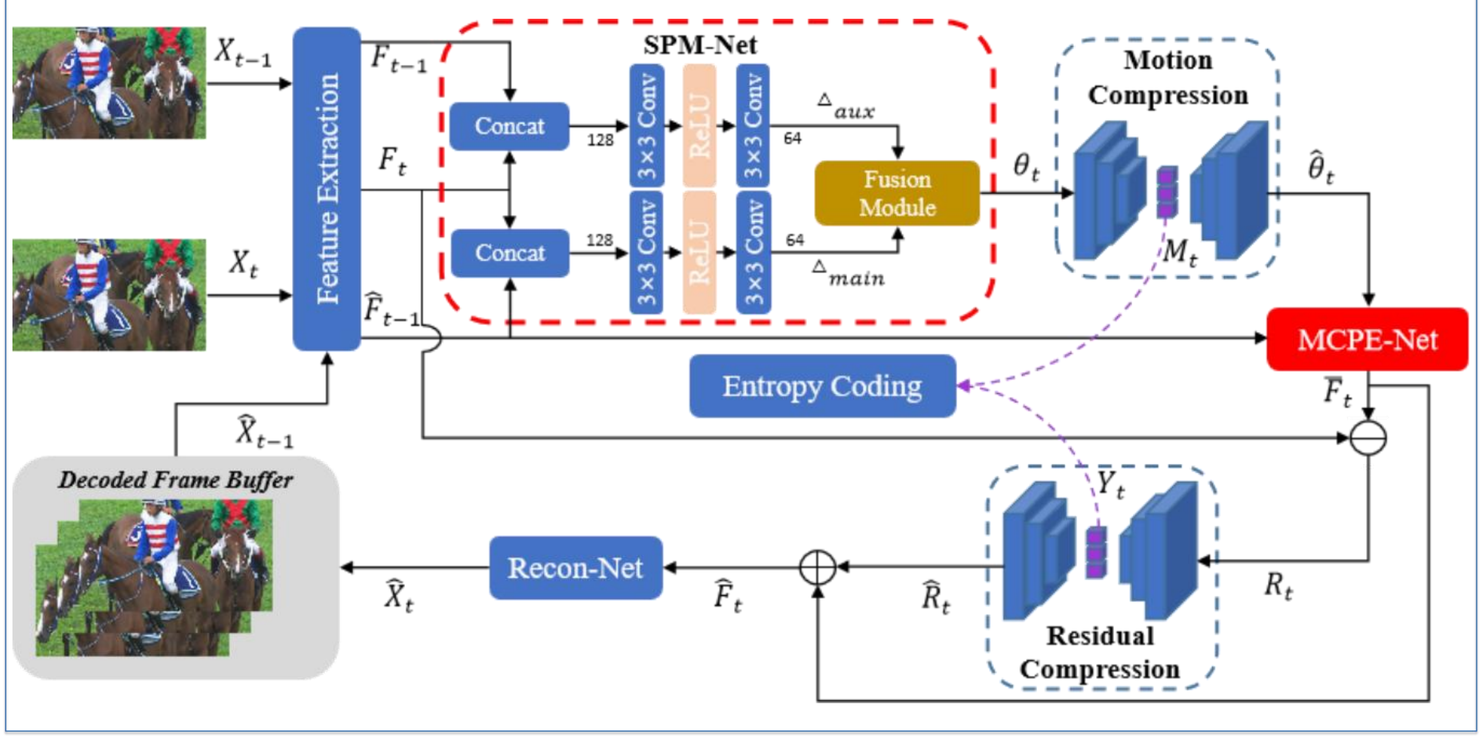
Problem & Proposed method

» Problem statement

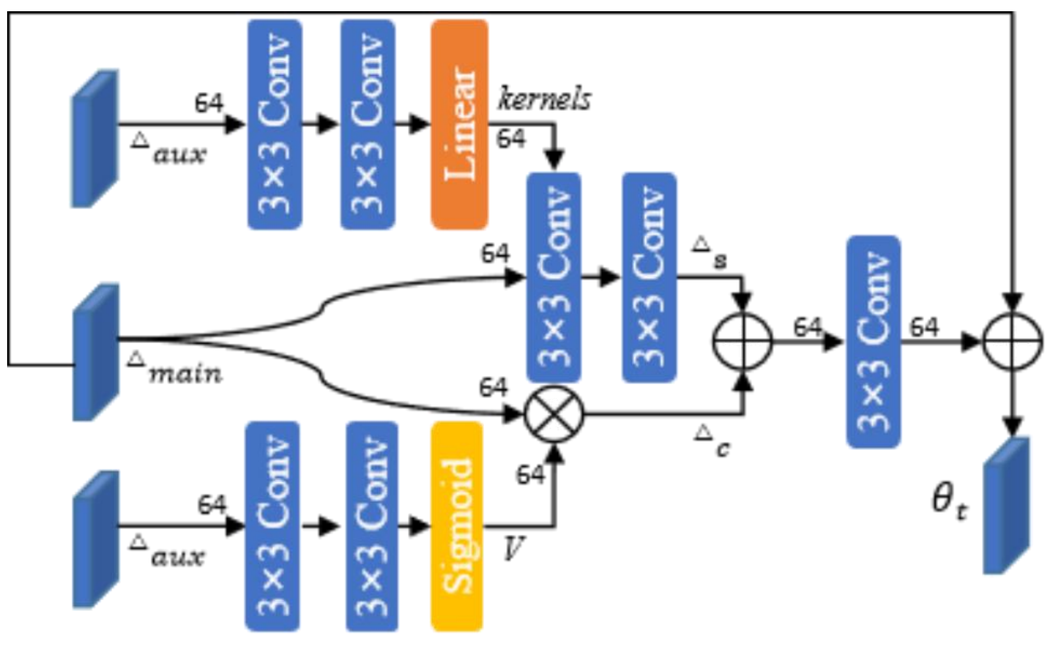
Method	Illustration	Characteristic
Previous & conventional	X_t, $\hat{X}_{t-1}$ → Motion Estimation	• Damage both the spatial structure of motion inferred and the corresponding residual; • Break the consistent nature across frames since the estimated motion is no longer consistent with the movement in the original video due to the distortion.
Ideal but not corresponding	X_t, X_{t-1} → Motion Estimation	• Spatial structure is preserved when estimating motion; • Non-correspondence at motion compensation stage.
Proposed	$\hat{X}_{t-1}$, X_t, X_{t-1} → Motion Estimation	• Spatial structure is preserved when estimating motion; • Without any non-correspondence at motion compensation stage.

How to use both of them efficiently?

» Overview of proposed method



» Architecture of *Fusion Module*



$$\begin{cases} \Delta_s = Conv_{3\times3} \circ Conv_k(\Delta_{main}),\ kernels = Linear \circ (Conv_{3\times3})^2(\Delta_{aux}), \\ \Delta_c = V \otimes \Delta_{main},\ \ V = Sigmoid \circ (Conv_{3\times3})^2(\Delta_{aux}), \end{cases}$$

$$\theta_t = \Delta_{main} + Conv_{3\times3}(\Delta_s + \Delta_c).$$

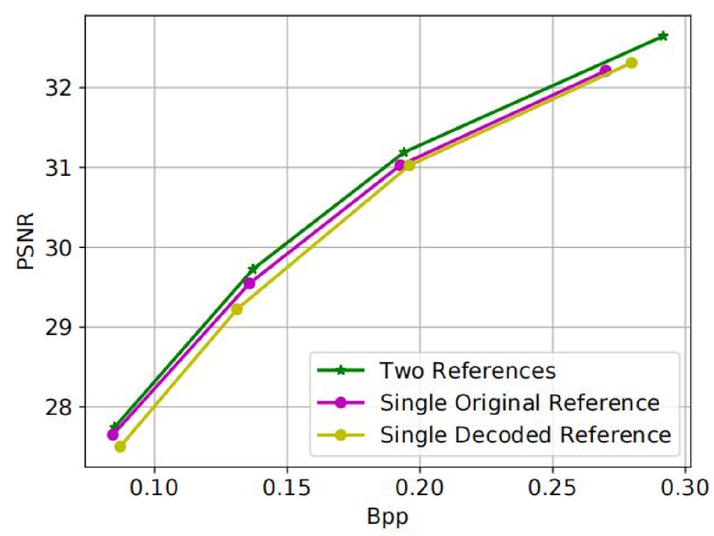
Experiments

» Experimental results

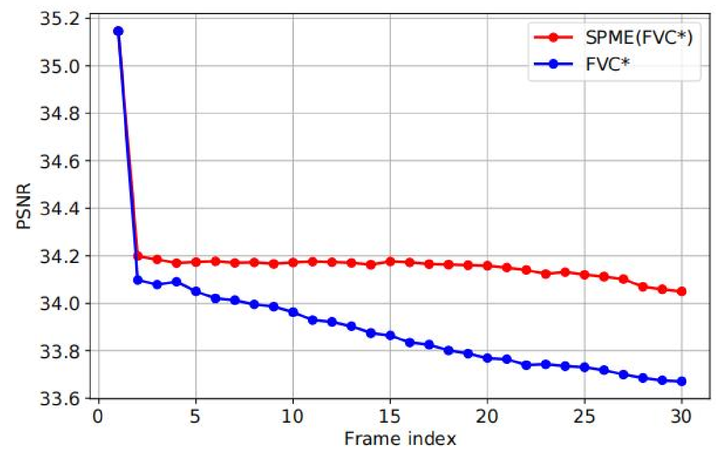
	FVC*	SPME (FVC*)	DCVC	SPME (DCVC)
HEVC Class B	-21.45	**-26.78**	-35.59	**-39.53**
HEVC Class C	-2.14	**-9.06**	-14.88	**-18.93**
HEVC Class D	-16.55	**-21.60**	-26.26	**-29.98**
HEVC Class E	8.31	**-11.08**	-17.69	**-21.04**
MCL-JCV	16.12	**-3.16**	-28.78	**-31.70**
UVG	-12.82	**-16.81**	-37.74	**-41.30**

BDBR results in terms of PSNR.

» Ablation studies



Effect of different reference frames.



The change of PSNR with time inside a GoP.

Conclusion and others

» Conclusion

- Identify a generic limitation of motion estimation in learned video compression;
- Propose a plug-and-play method to use the original previous frame as auxiliary data for motion estimation.

» Citation

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» Reproducibility

Code and Appendix are available at: https://github.com/gaohan-12/SPME.

» Contact

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