Frequency-Temporal Feature Integration for Compressed Video Action Recognition

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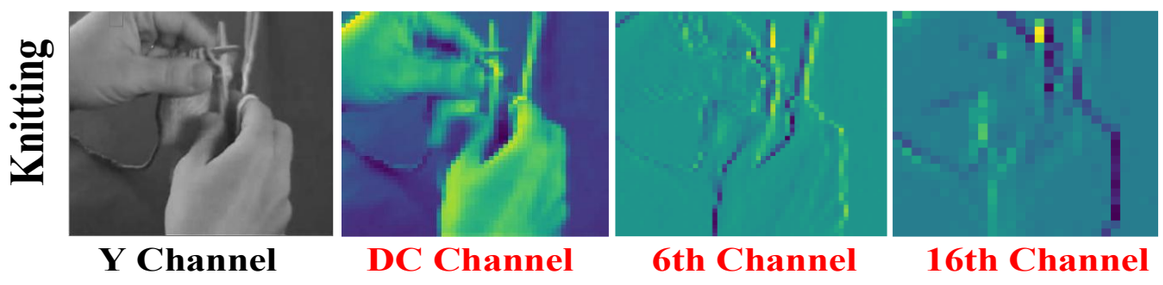
Motivations

Challenges:

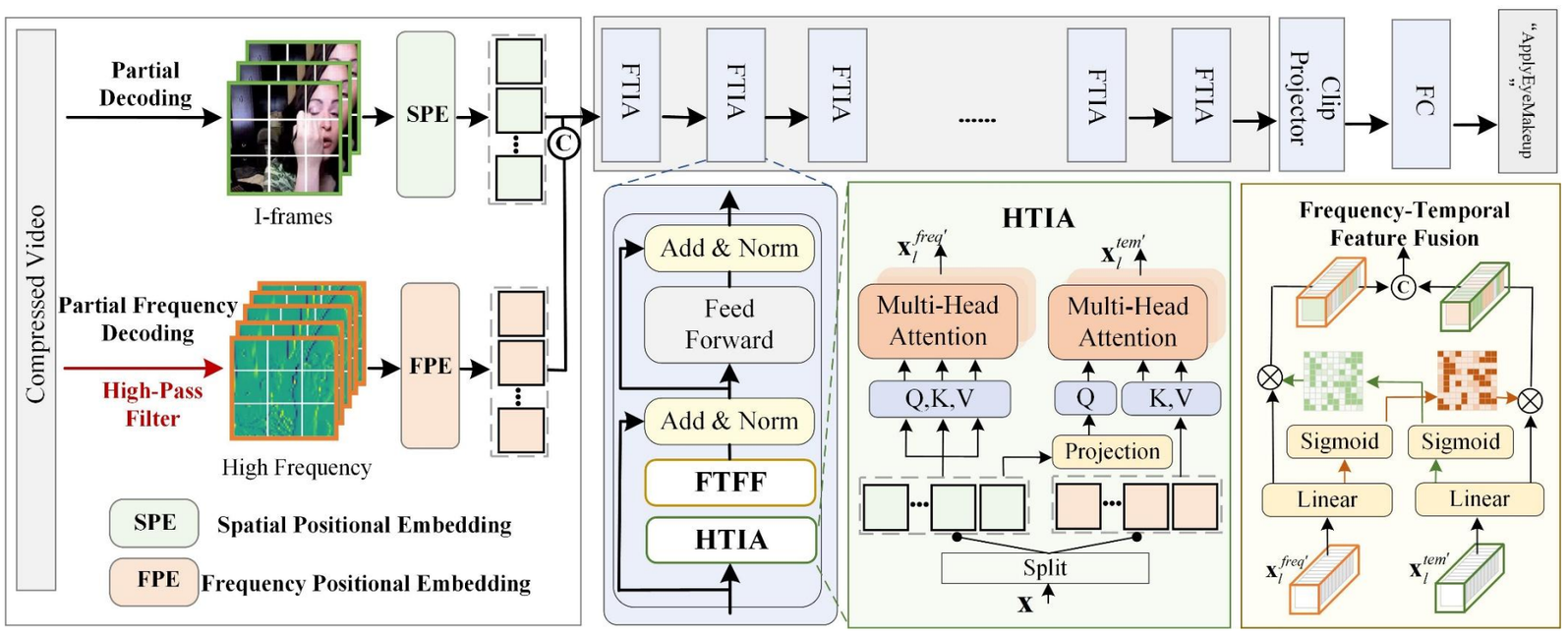
- Transformer-based action recognition methods often ignore **high-frequency motion cues** (e.g., edge textures, motion boundaries), leading to **loss of fine-grained temporal details.**
- Existing compressed video approaches mainly focus on low-frequency global context, **overlooking local high-frequency dynamics** that are crucial to distinguish similar actions (e.g., writing vs. typing).
- There is a need for a model that balances temporal and frequency information, efficiently integrating both global motion and fine edge cues.



Contributions

- FreqTNet: A ViT-based framework achieving temporal-frequency balance for compressed video action recognition.
- FTE: Frequency-Aware and Temporal-Spatial Embedding compensates for high-frequency loss in ViT.
- FTIA: Frequency-Temporal Interaction Attention enables hierarchical fusion of temporal and frequency features.
- Achieves **state-of-the-art** accuracy in compressed video action recognition with **low computational cost.**

Method



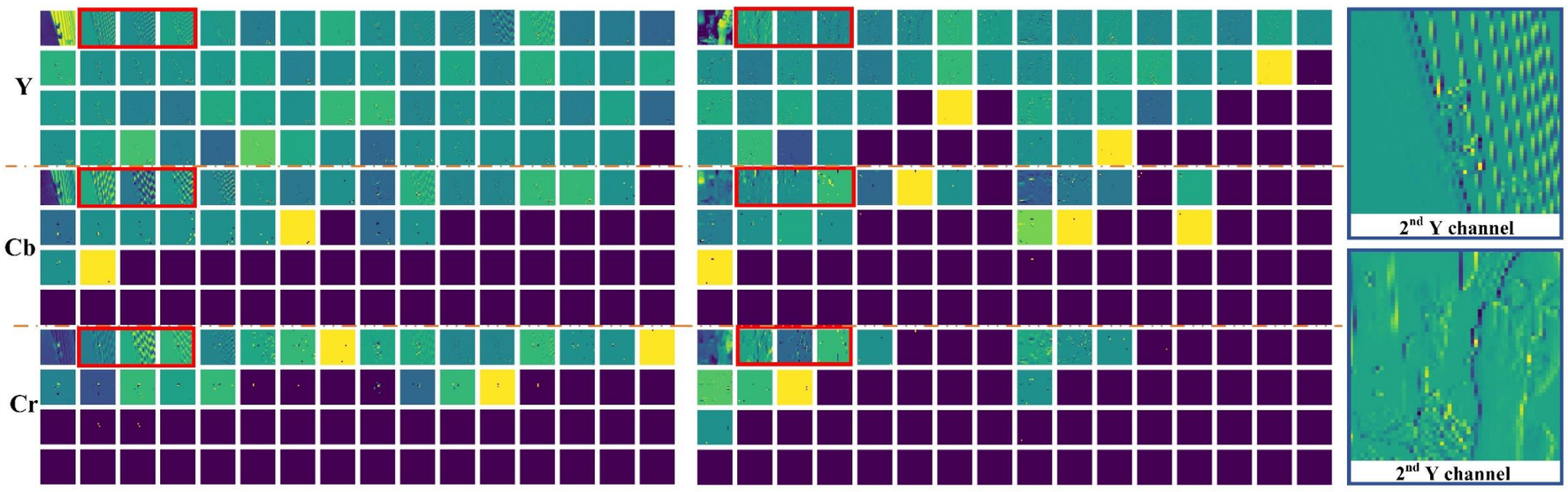
Overview of frequency-temporal feature integration for compressed video action recognition

Frequency-Aware and Temporal-Spatial Embedding (FTE)

- Extracts temporal features from I-frames and high-frequency DCT features from P-frames.
- Encodes both into unified tokens, enabling the model to perceive global motion and fine edge details simultaneously.

Frequency-Temporal Interaction Attention (FTIA)

- High-frequency & Temporal Interaction Attention for cross-domain correlation
- Feature Fusion for adaptive integration of temporal and frequency information



Visualization of 192 channels from Y, Cb, and Cr components.

Experimental Results

Quantitative results:

Methods	Published on	Modality	GFLOPs	Kinetics-400	UCF-101	HMDB-51
Video action recognition						
Vita-CLIP B/16 [35]	CVPR'23	RGB	1164	81.8	-	-
AIM B/16 [39]	ICLR'23	RGB	2316	83.9	-	-
BIKE B/16 [37]	CVPR'23	RGB	1104	83.9	-	-
M^2-CLIP B/16 [31]	AAAI'24	RGB	2453	83.4	-	-
OmniViD [29]	CVPR'24	RGB	-	83.6	-	-
EPK-CLIP B/16 [41]	ESWA'24	RGB	1732	84.3	97.4	77.7
GBC B/16 [40]	TCSVT'24	RGB	1882	84.4	**97.7**	76.8
InternVideo2 1B [33]	ECCV'24	RGB	-	91.3	-	-
OmniVec2 [28]	CVPR'24	RGB	-	**93.6**	-	-
Compressed video action recognition						
CoViAR [36]	CVPR'18	RGB	3775	69.1	90.4	59.1
Faster-FCoViAR [38]	BMVC'21	Frequency	2400	69.3	91.2	63.2
MM-ViT [6]	WACV'22	RGB	2460	-	93.3	-
LEA-Net [13]	ICMM'23	RGB	-	-	94.8	72.2
CoViFocus [42]	TCSVT'23	RGB	296	72.0	95.8	74.8
Fenet [22]	ICIP'23	Frequency	234	72.6	94.5	73.8
DSDMT [24]	TCSVT'23	RGB	141	74.1	95.8	74.9
F2D-SIFPNet [23]	APIN'24	Frequency	192	74.0	95.8	74.1
PKD [27]	BMVC'24	RGB	612	-	93.3	66.3
CFM-Net [19]	ICASSP'25	RGB	48	-	94.8	75.7
Biswas et al. [4]	Arxiv'25	RGB	765	74.2	95.6	74.6
FreqTNet (ours)		Freq + RGB	916	85.1	**97.7**	**79.4**

Preprocessing time (ms):

Input	Modality	Frames	Pre Time	Top1
Coviar frames	RGB	8	76.40	84.1
Fenet frames	Frequency	8	**37.68**	83.1
DCT	Frequency	8	2325	83.9
FreqTNet (DCT)	Frequency + RGB	3 + 5	1481	**85.3**
FreqTNet	Frequency + RGB	3 + 5	52.20	85.1

Qualitative results: