FAST: A Framework to Accelerate Super-Resolution Processing on Compressed Videos

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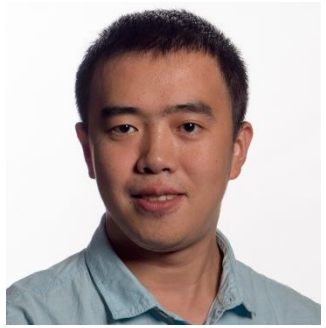
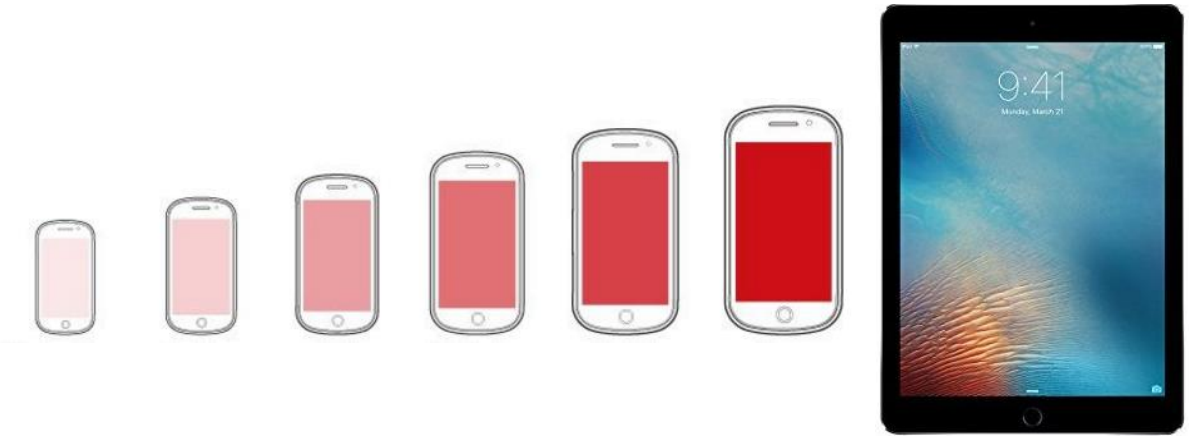


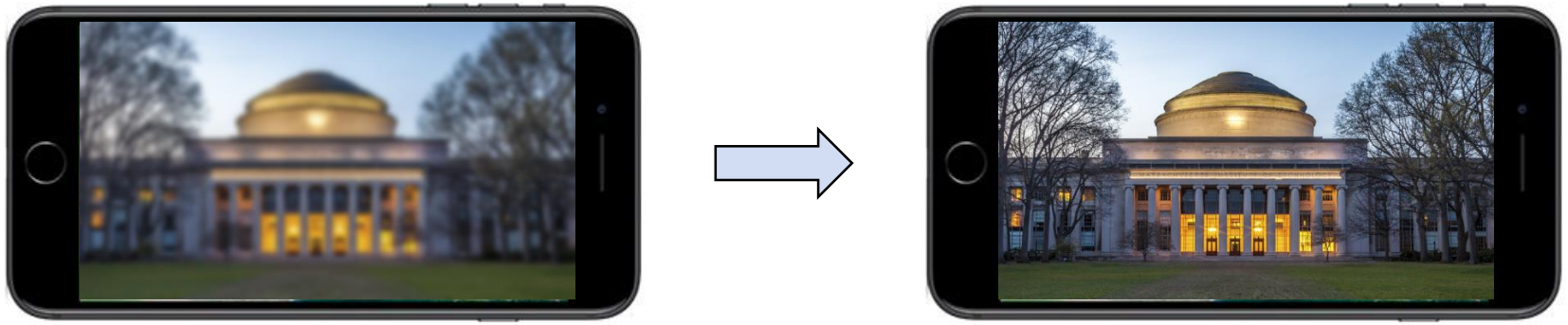
http://www.mit.edu/~sze/fast.html

Super-Resolution on Mobile Devices

Mobile phones are everywhere



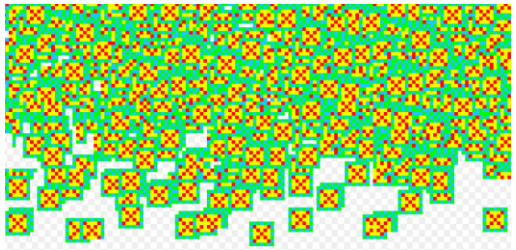
Screens are getting larger



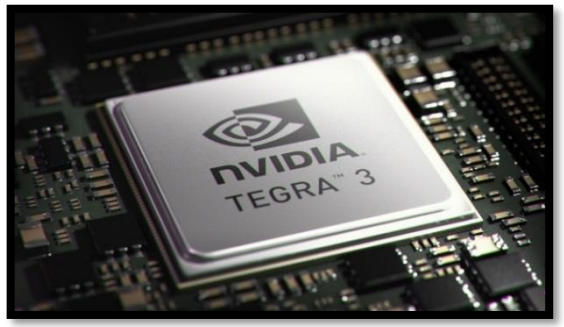
Run **Super-Resolution** to Improve the Viewing Experience of Lower-Resolution Content

Challenges

High input resolution
2K → 4K

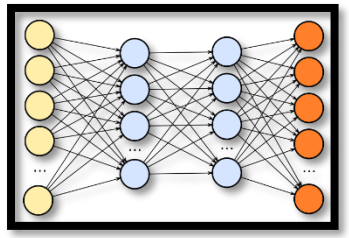


High-power
180 W
94 °C

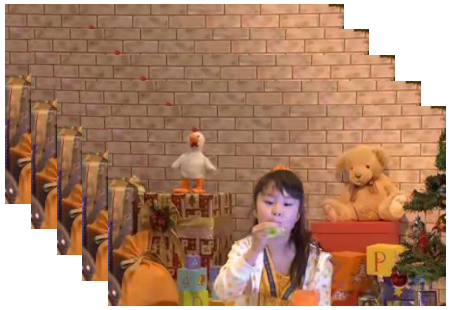


Low performance
Embedded GPU

Research Goal



SR algorithm



Compressed video

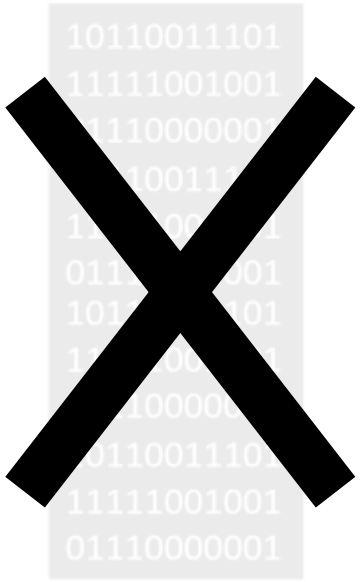
FAST

SR
15x faster

Real-time

A framework that accelerates **any SR** algorithm by up to **15x** when running on compressed videos

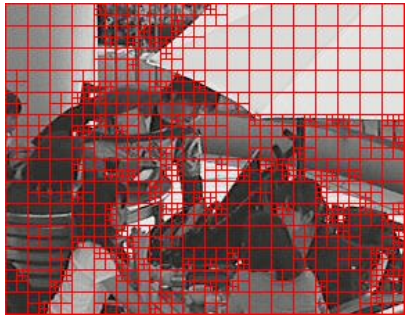
Using Free Information from Compressed Videos



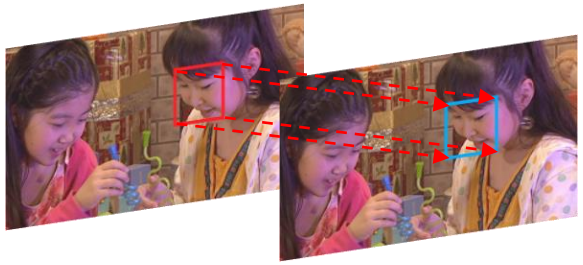
Compressed video

Decode

Pixels



Block-structure



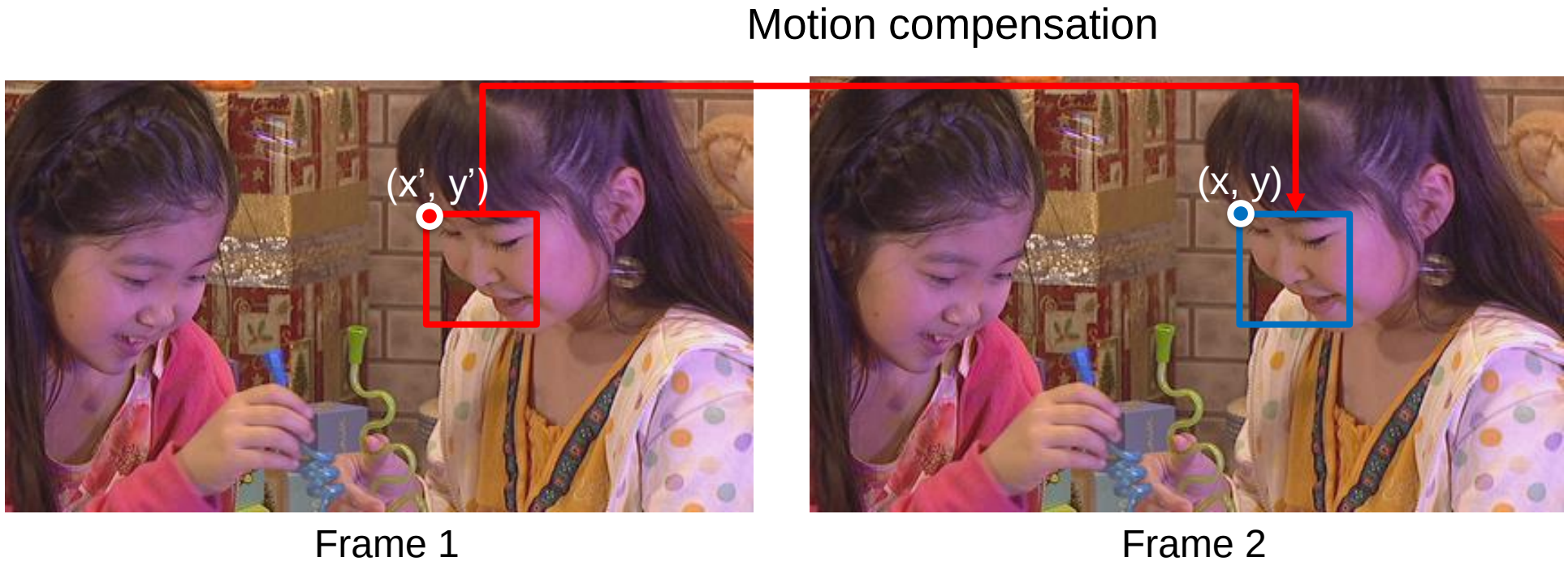
Motion-compensation

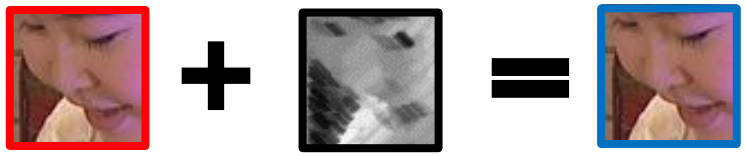
Video as a stack of pixels

Representation from compressed video

This representation can help **SIGNIFICANTLY ACCELERATE** super-resolution

Reviewing Motion Compensation



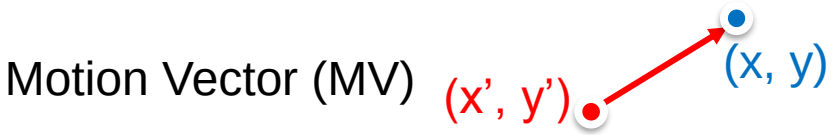


Encode

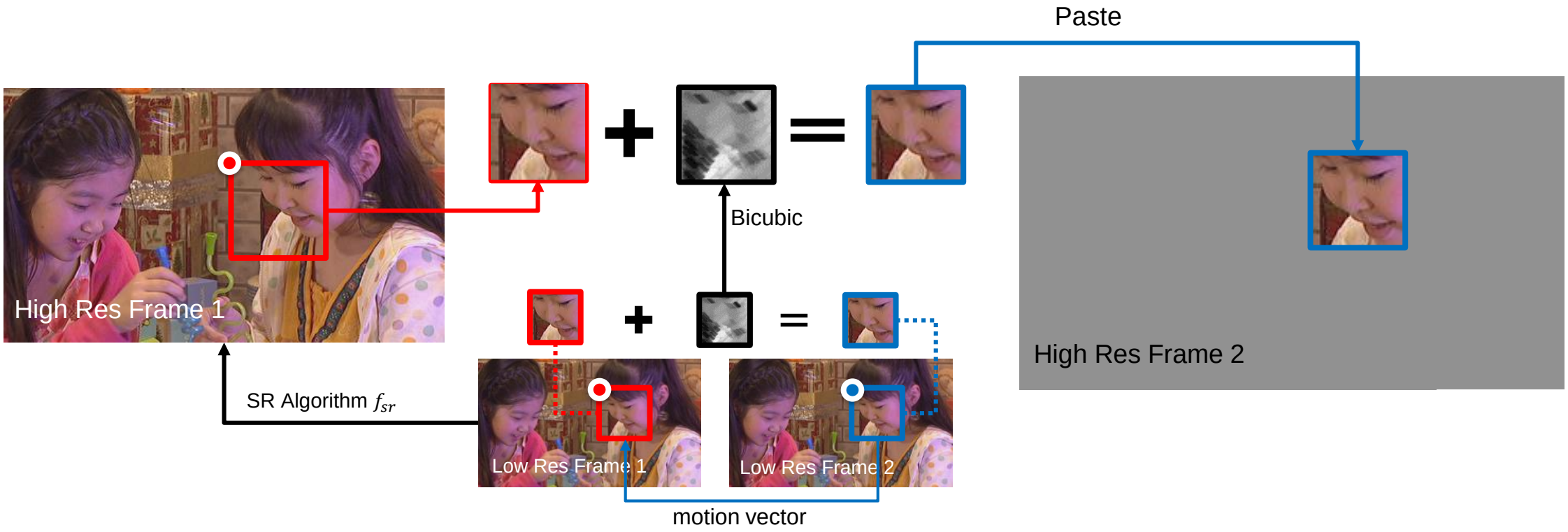
0100110110
1101100111
0111111001
0010111000
1011001000
101011

- Block info
- Motion vector
- Residual
- …

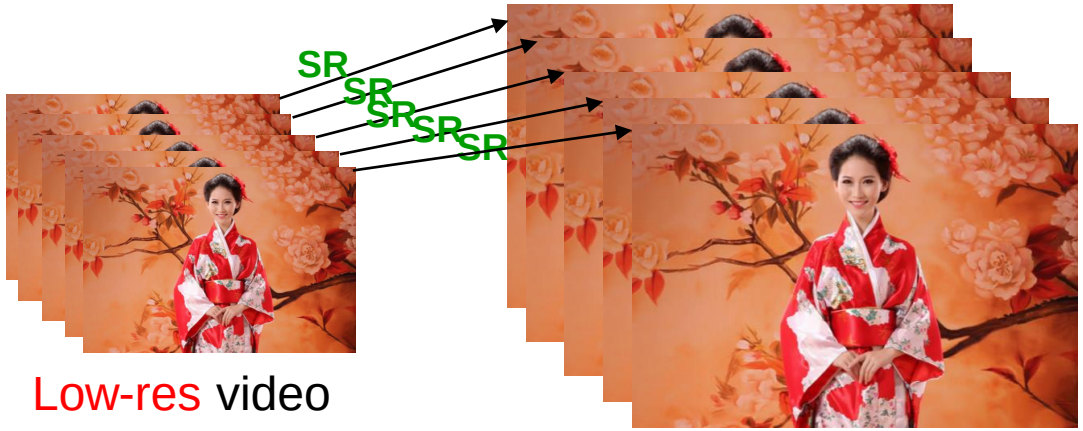
Available For **FREE**

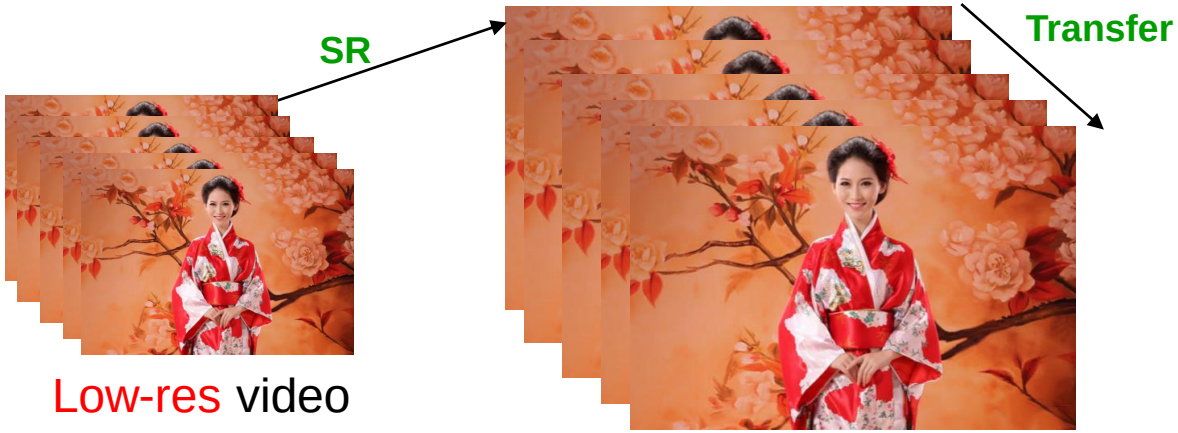


Transferring the Super-Resolution Results

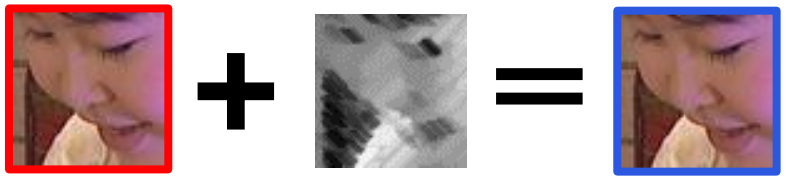


Transfer is Lightweight





Transfer allows SR to run on only **a subset of frames**

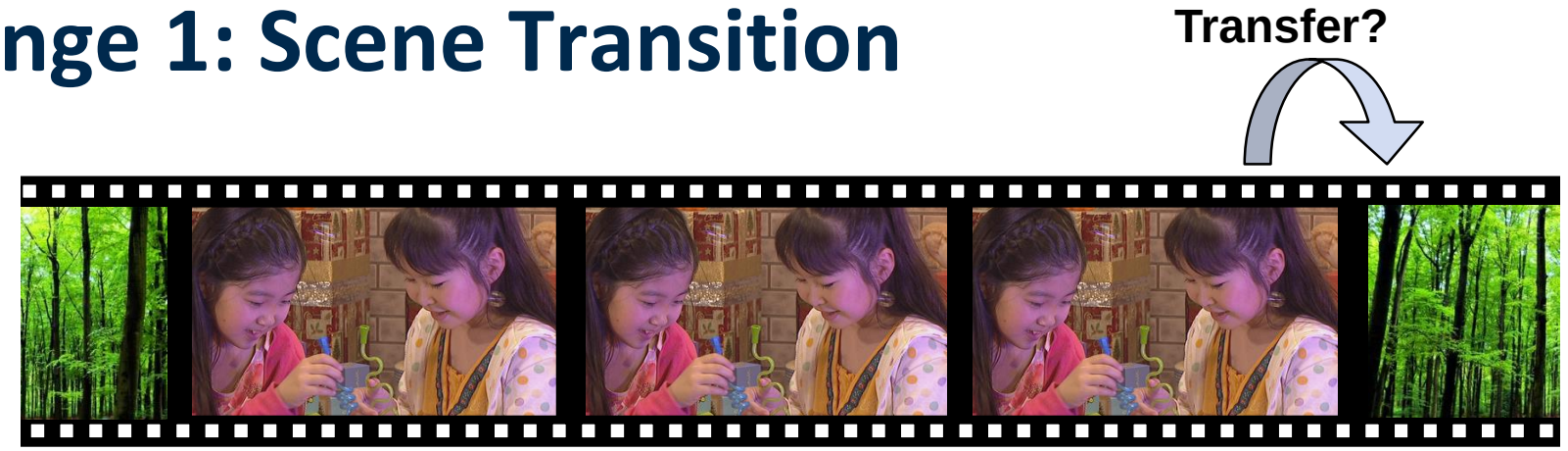


Fractional Interpolation + **Bicubic Interpolation** =

Skip Flag

The complexity of the transfer is **comparable to bicubic interpolation**.
Transfer N frames, accelerate N times

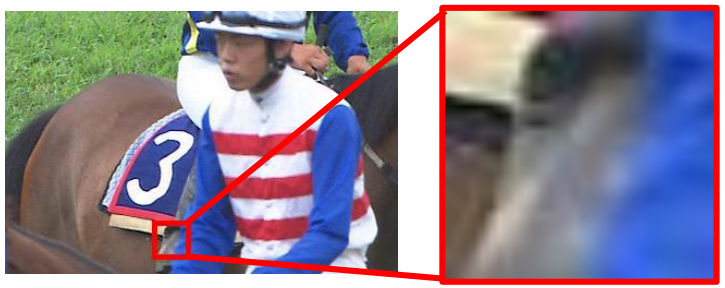
Challenge 1: Scene Transition



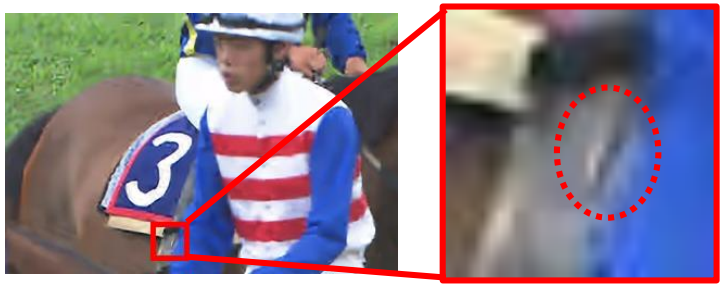
Transfer **will NOT work** if there is a **transition of scenes**

GoP structure in the compressed video **provides video segmentation for free**

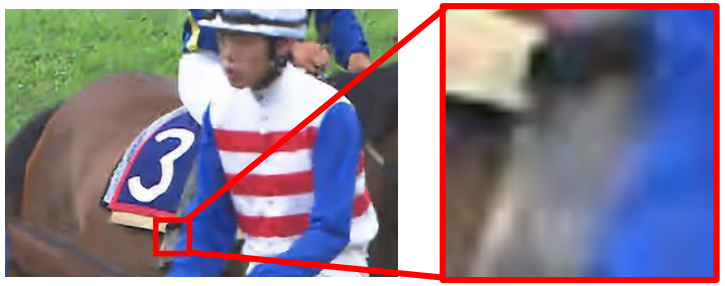
Challenge 2: Non-Optimal Prediction by Encoder



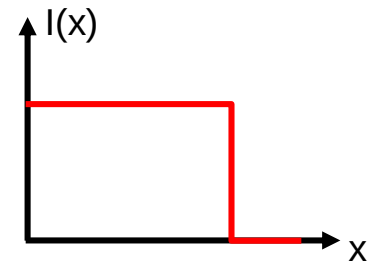
Ground-truth



Non-adaptive

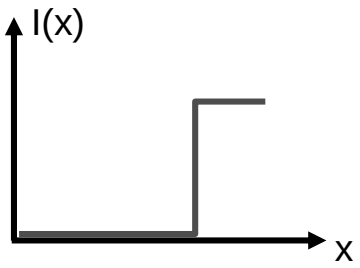


Adaptive



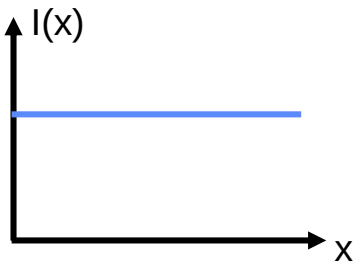
Low res prediction

+

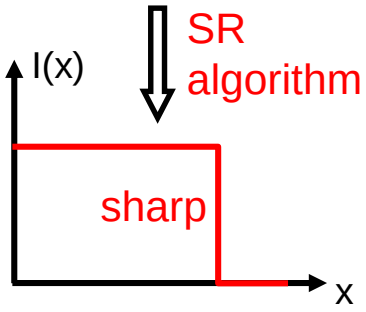


Low res residual

encode

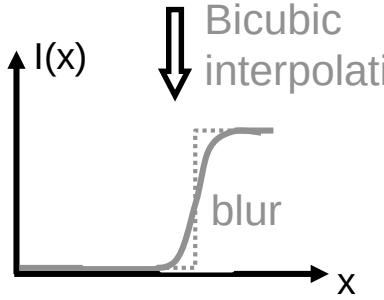


Low res input



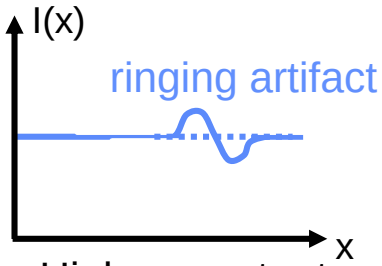
High res prediction

+



High res residual

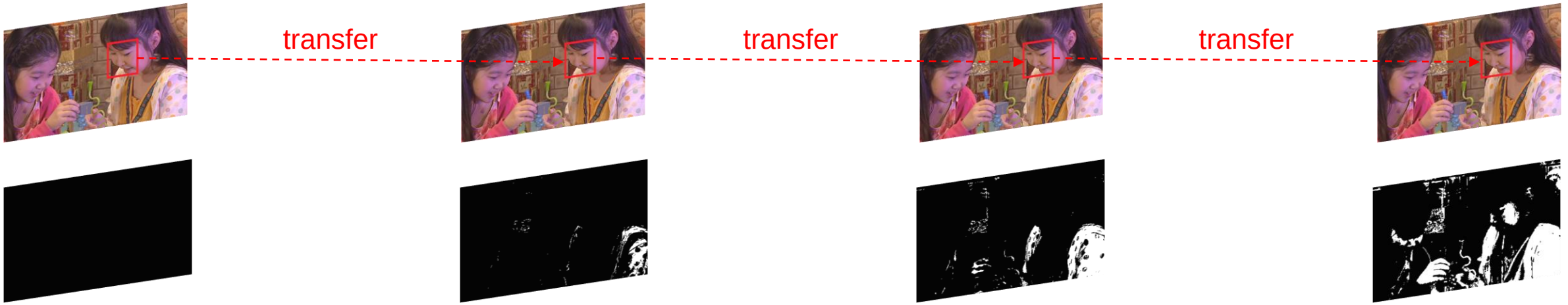
reconstruct



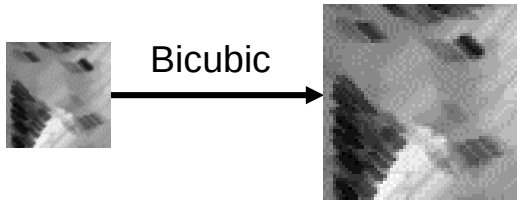
High res output

FAST **stops the transfer** on blocks with **large residual**

Challenge 3: Thresholding the Accumulated Error

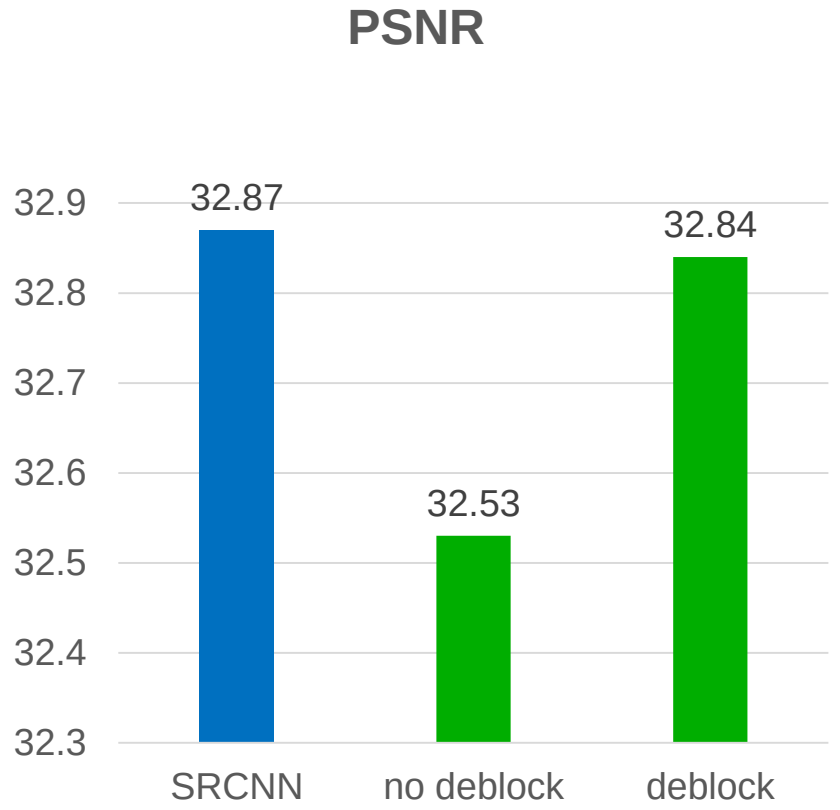


When a SR result gets transferred multiple times, the error **accumulates**



FAST estimates the accumulated error as the **accumulated Laplacian of the residual**, and stops the transfer when it exceeds a threshold

Challenge 4: Non-overlapping Blocks and Block Artifacts



FAST applies the **deblocking filter** to alleviate the blocking effect caused by **non-overlapping block division**

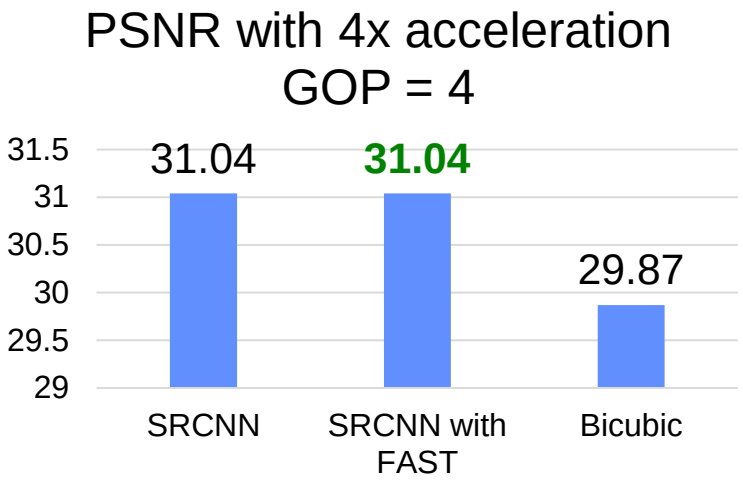
Evaluation: Accelerating SRCNN

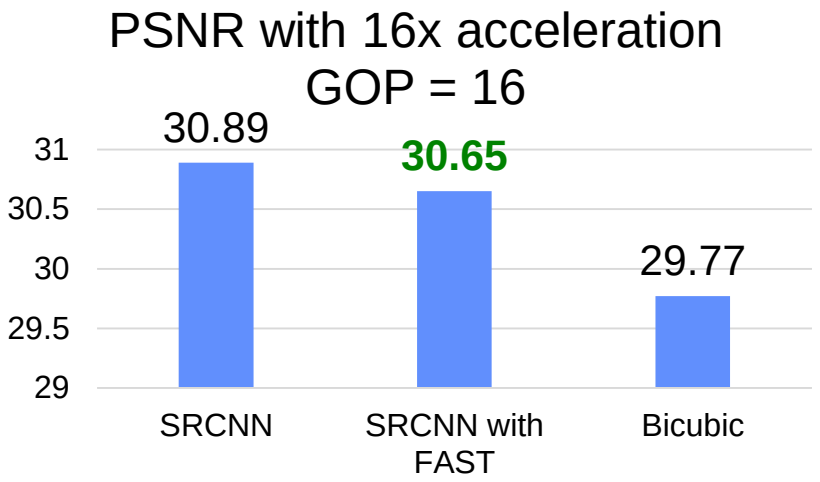
PartyScene

RaceHorse

BasketballPass

Examples of videos in the test set (20 videos for HEVC development)





4 × acceleration with NO PSNR LOSS. **16** × acceleration with 0.2 dB loss of PSNR

Visual Evaluation

Bicubic

SRCNN

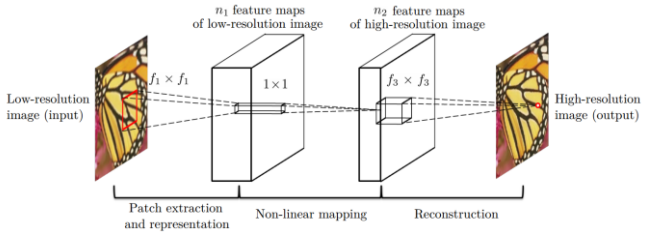
SRCNN with FAST

Ground-truth

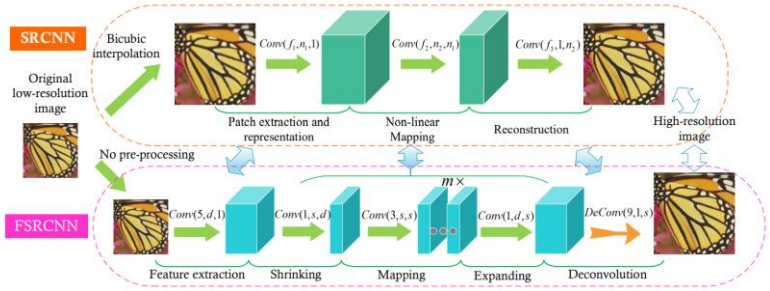
Visual Evaluation

SRCNN **FAST + SRCNN** **Bicubic**

Related Work

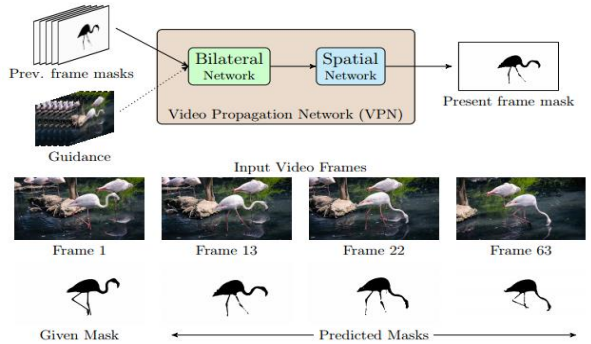


SRCNN (Dong et, al. ECCV 14)

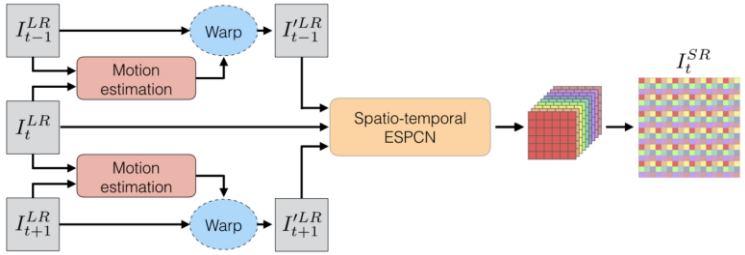


Faster SRCNN (Dong et, al. ECCV 16)

Our framework can **accelerate** existing SR algorithms.



Video Propagation Network
(Jampani et, al. CVPR 17)



Spatio-Temporal Networks and Motion Compensation (Caballero et, al., Arxiv 16)

More **efficient transfer** using **compressed video information**

Contributions

- **Transfer** the SR results guided by **motion vector**
- **Adaptively** perform the transfer by thresholding on the **residue, and accumulated Laplacian**
- **Accelerating** most of the SR algorithm by up to **15x** running on videos with **minimal PSNR loss**