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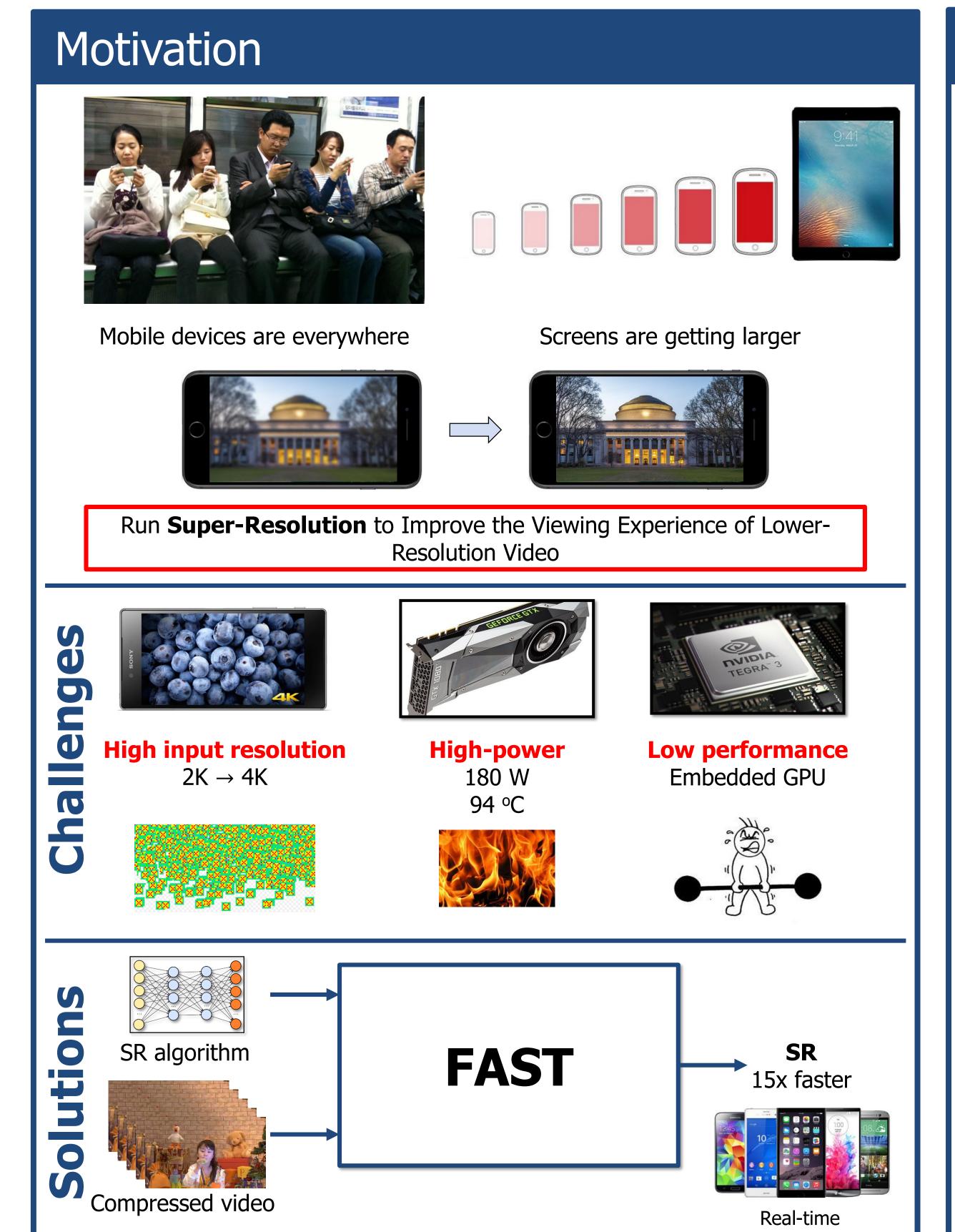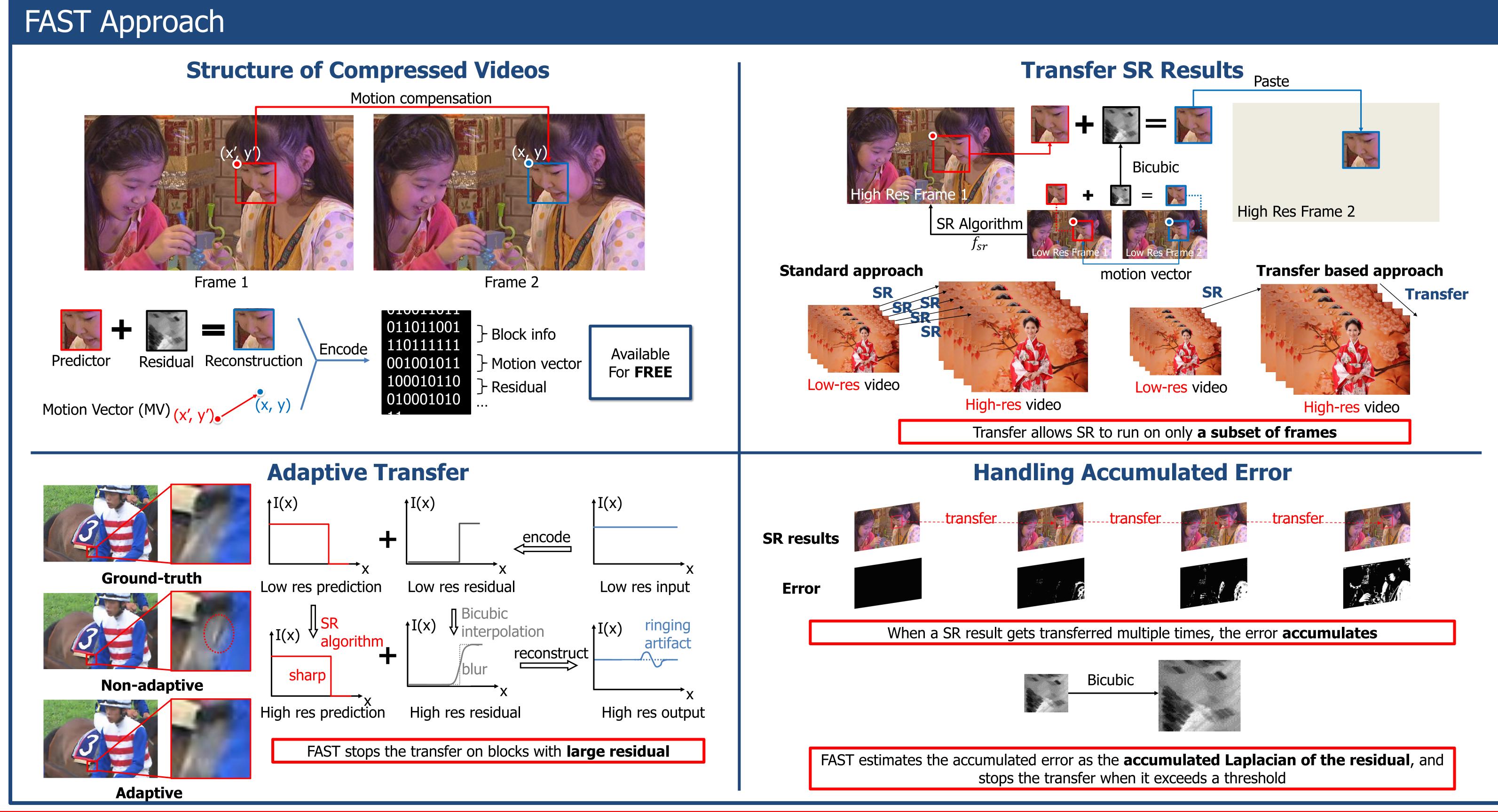
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Motivation

Mobile devices are everywhere

Screens are getting larger

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

Challenges

High input resolution
2K → 4K

High-power
180 W
94 °C

Low performance
Embedded GPU

Solutions

SR algorithm

Compressed video

FAST

SR
15x faster

Real-time

FAST Approach

Structure of Compressed Videos

Motion compensation

(x', y')

(x, y)

Frame 1

Frame 2

Predictor + Residual = Reconstruction → Encode

010011011
011011001
110111111
001001011
100001010
010001010
...

▶ Block info
▶ Motion vector
▶ Residual

Available For **FREE**

Motion Vector (MV) (x', y') (x, y)

Transfer SR Results

Paste

High Res Frame 1

Bicubic

High Res Frame 2

SR Algorithm f_{sr}

Low Res Frame 1   Low Res Frame 2

motion vector

Standard approach

SR
SR SR
SR SR
SR

Low-res video

High-res video

Transfer based approach

SR

Transfer

Low-res video

High-res video

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

Adaptive Transfer

Ground-truth

Non-adaptive

Adaptive

$I(x)$ Low res prediction + $I(x)$ Low res residual → encode → $I(x)$ Low res input

$I(x)$ High res prediction (SR algorithm, sharp) + $I(x)$ High res residual (Bicubic interpolation, blur) → reconstruct → $I(x)$ High res output (ringing artifact)

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

Handling Accumulated Error

SR results — transfer — transfer — transfer — transfer

Error

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

Bicubic

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

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FAST is as **cheap** as **bicubic interpolation**. FAST accelerates **most of SR** algorithms on **compressed** videos by ~15x **FOR FREE**

Other Challenges

Handling Scene Transition

Transfer?

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

Group-of-Picture (GoP) Structure

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

Block Effect for Non-Overlapping Blocks

SRCNN

No deblocking

With deblocking

PSNR

	PSNR
SRCNN	32.87
no deblock	32.53
deblock	32.84

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

Results

PartyScene   RaceHorse   BasketballPass

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

PSNR with **4x** acceleration

	PSNR
SRCNN	31.04
SRCNN with FAST	**31.04**
Bicubic	29.87

PSNR with **16x** acceleration

	PSNR
SRCNN	30.89
SRCNN with FAST	**30.65**
Bicubic	29.77

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

Ground-truth   SRCNN   SRCNN with FAST   Bicubic

Video playback is available on the project website