Burst Technology for Image HDR

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Course Website:
http://webpages.uncc.edu/jfan/itcs5152.html

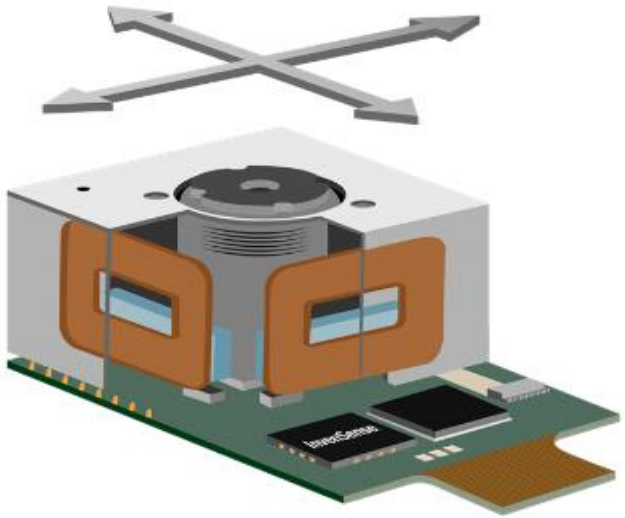
Image HDR

Image HDR

How to collect more light

larger aperture	longer exposure	flash

nokia.com



invensense.com

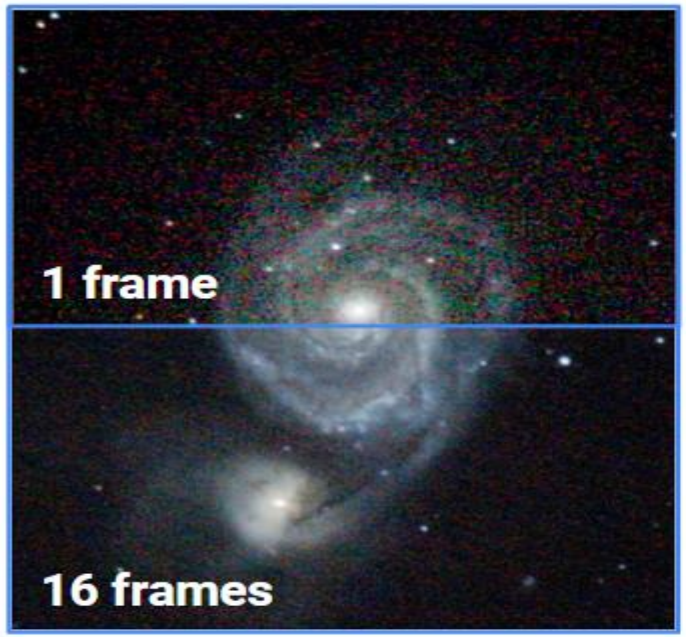
light.co

[Petschnigg et al., 2004]

Image HDR

How to collect more light

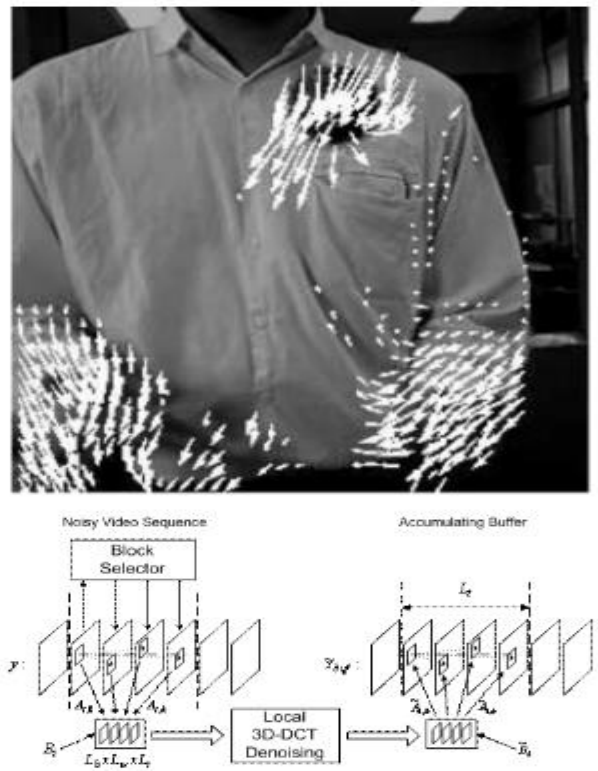
multiple photos over time



weatherandsky.com

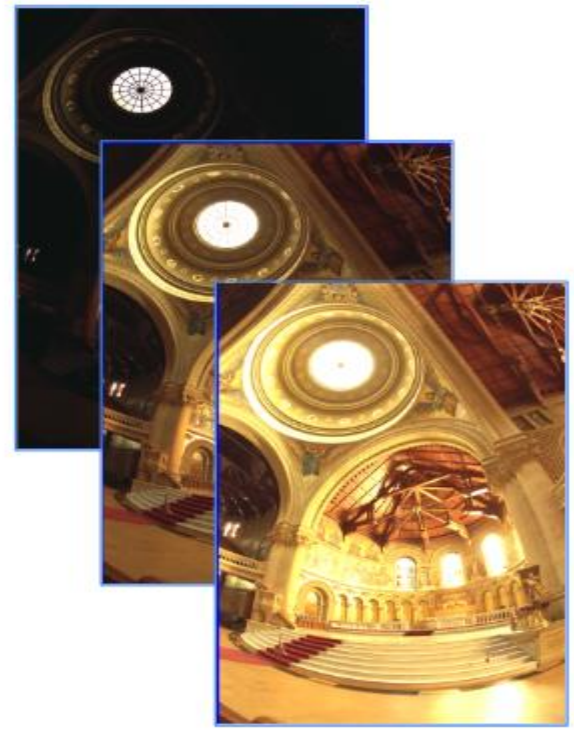
image stacking

[Fruchter and Hook, 2002]



video denoising

[Kokaram, 1993]
[Dabov et al., 2007]
[Liu et al., 2014]



exposure bracketing

[Debevec et al., 2007]
[Gallo and Sen 2016]

Image HDR

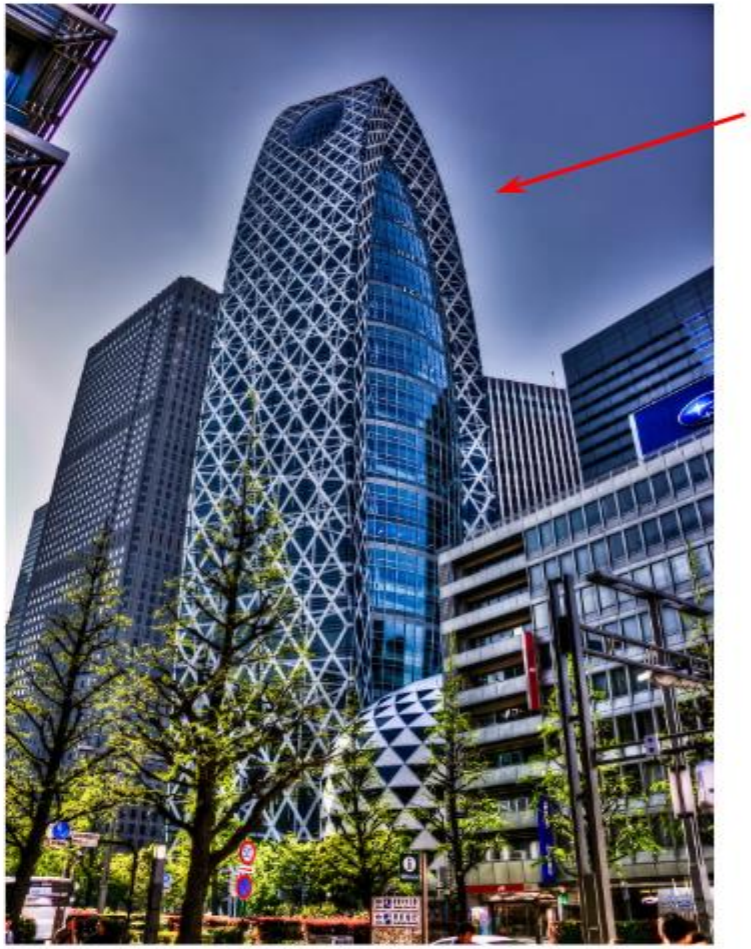
Computational photography pitfalls

ghosting

cartooniness

flickr.com, aerialcamera@

HDR halos



flickr.com, thomassmart@

Burst Technology from Google

Underexposure for HDR

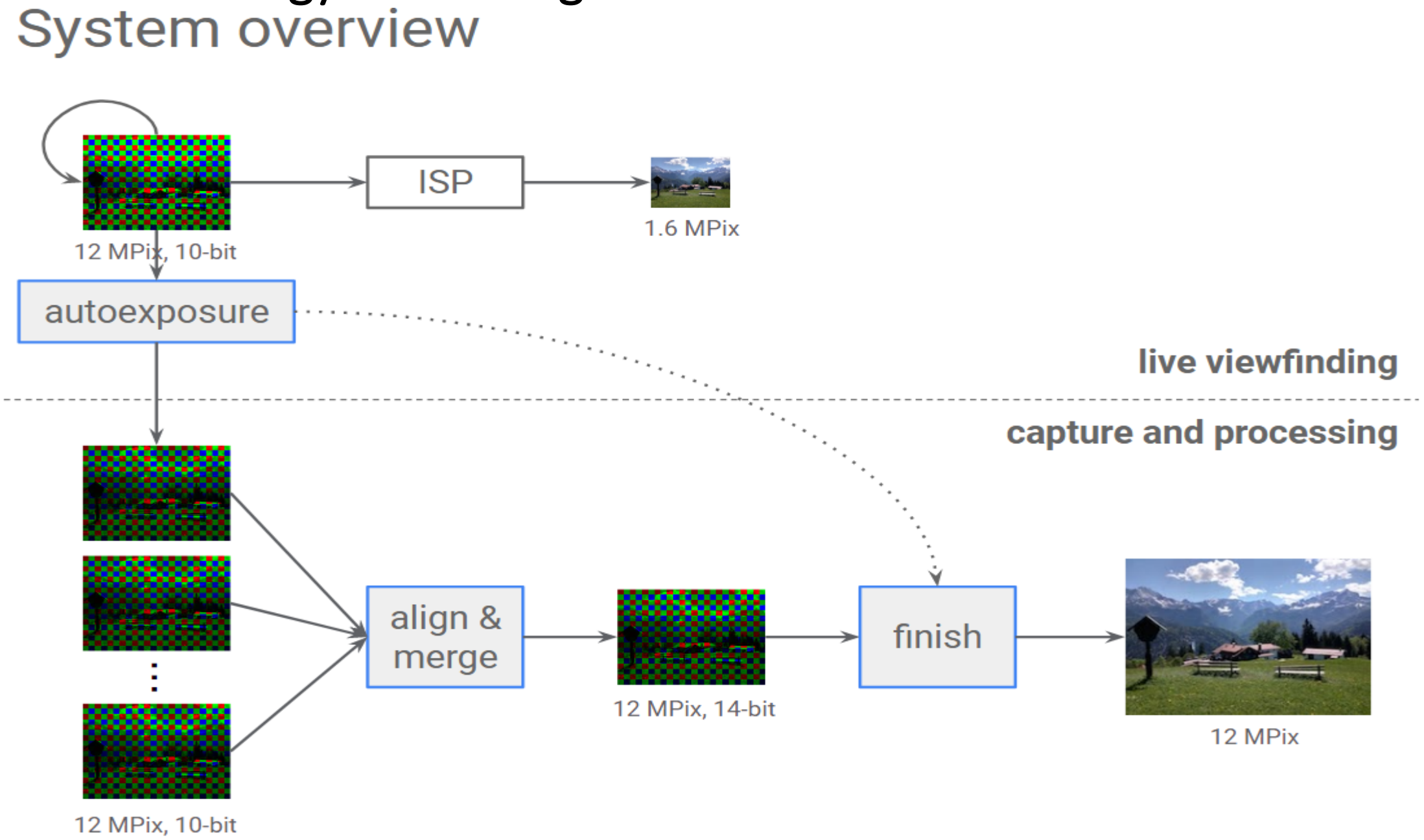
- HDR capture as noise reduction [Hasinoff et al. 2010] [Zhang et al. 2010]

single underexposed shot
- low SNR

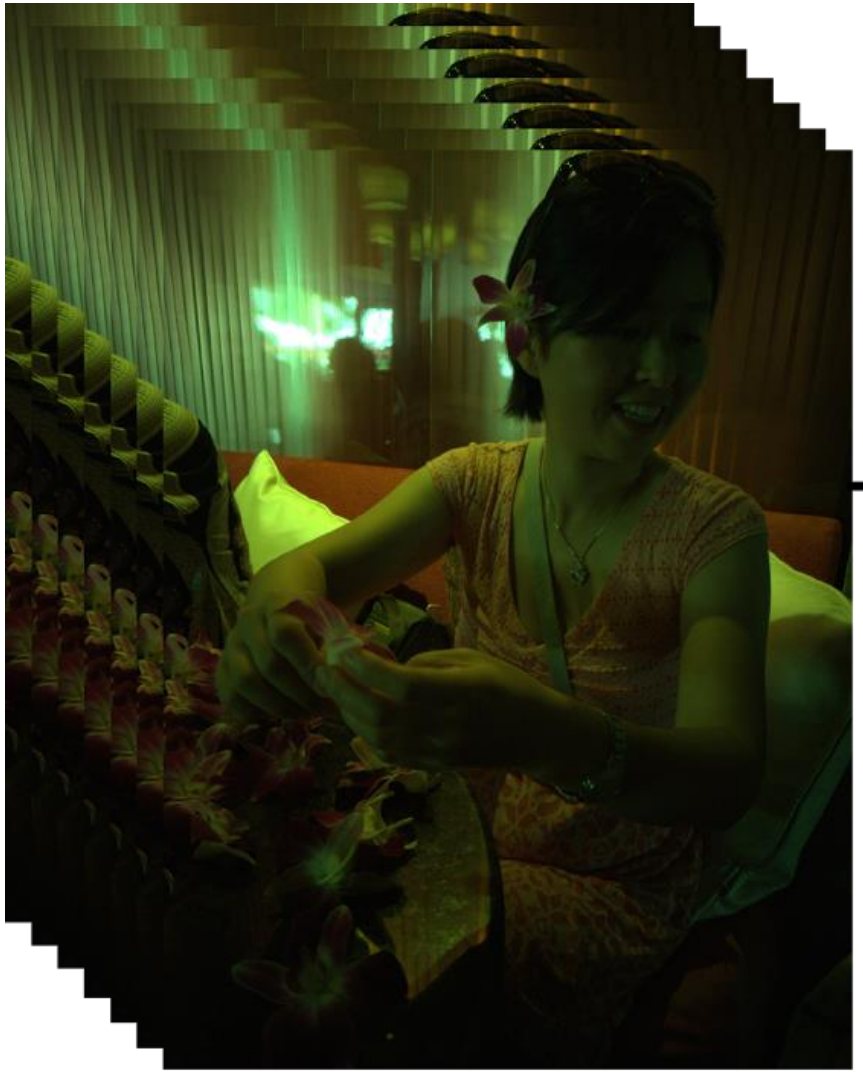
exposure bracketing
- higher SNR
- challenging merge

underexposed burst
- moderate SNR
- more robust merge

Burst Technology from Google

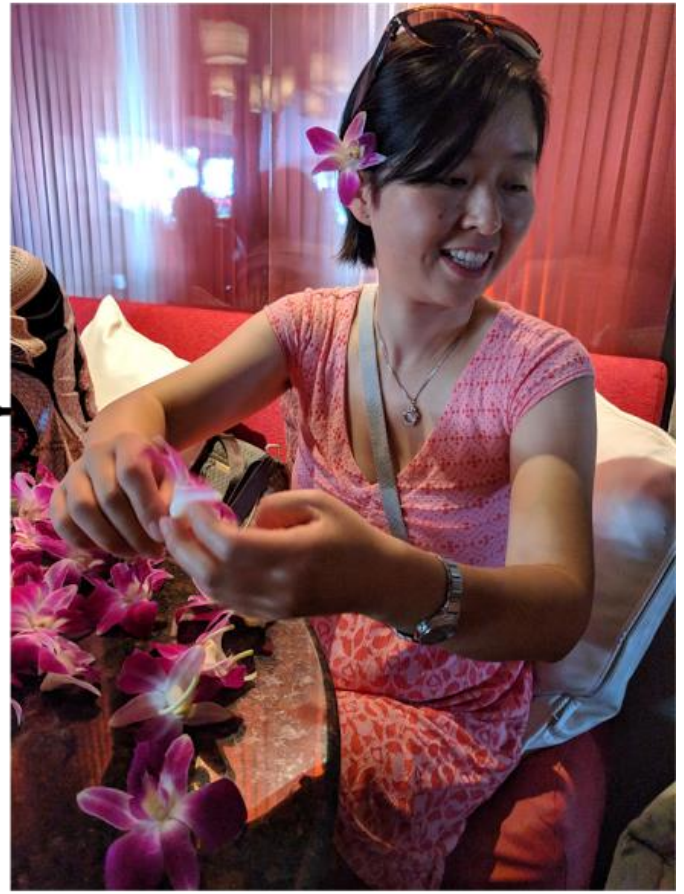


Burst Technology from Google



Burst of raw frames

Merged raw image



Final high-quality result

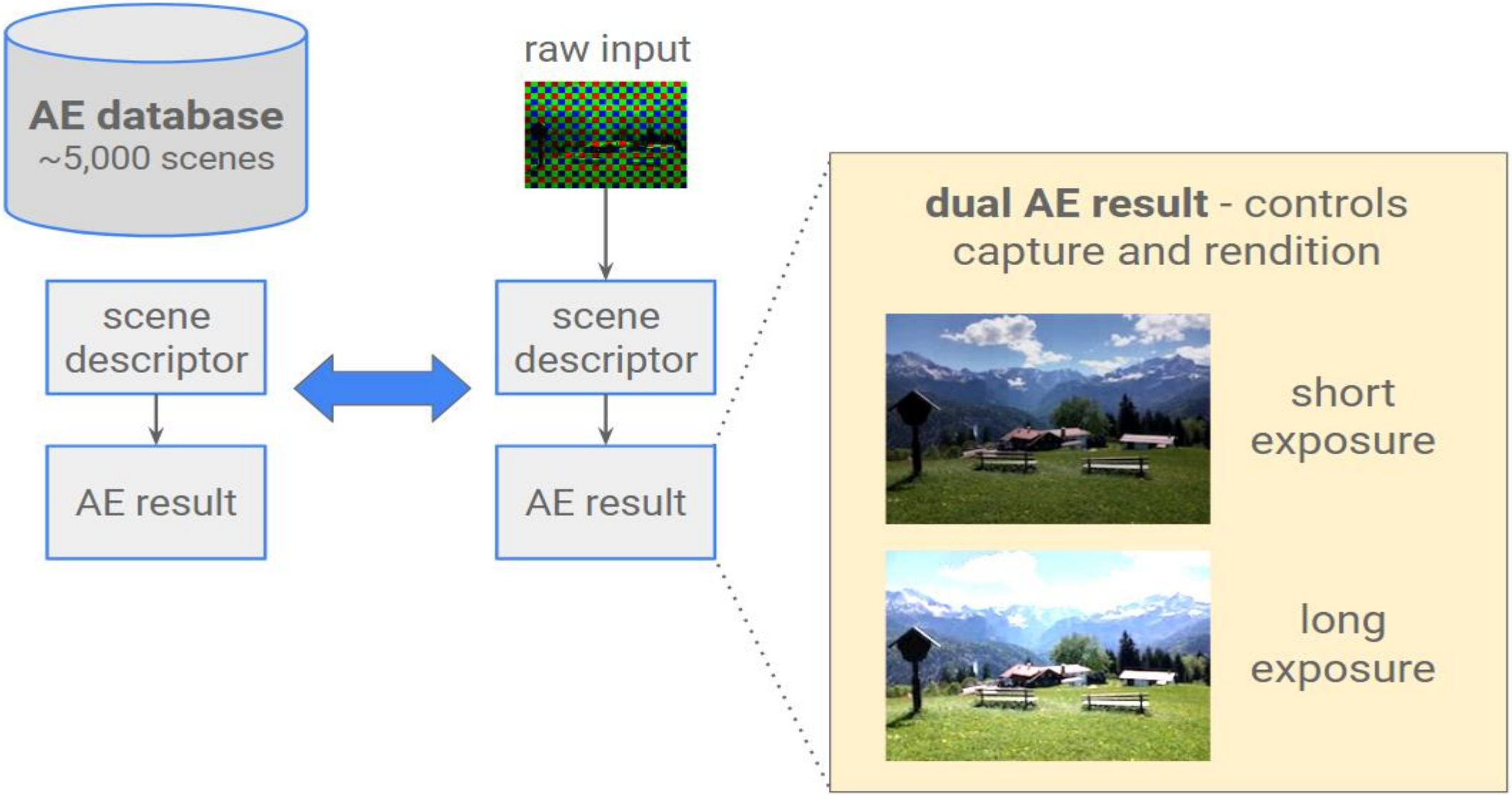
Burst photography for high dynamic range and low-light imaging on mobile cameras from Google

Burst photography is the key idea underlying the HDR+ software on Google's recent smartphones, and a fundamental computational photography technique for improving image quality. Every photo taken with HDR+ is actually a composite, generated by capturing and merging a short burst of full-resolution photos.

Burst photography provides the benefits associated with collecting more light, including reduced noise and improved dynamic range, but it avoids the motion blur that would come from increasing exposure times. This is particularly important for small smartphone cameras, whose size otherwise limits the amount of light they can capture.

Burst Technology from Google

Example-based autoexposure

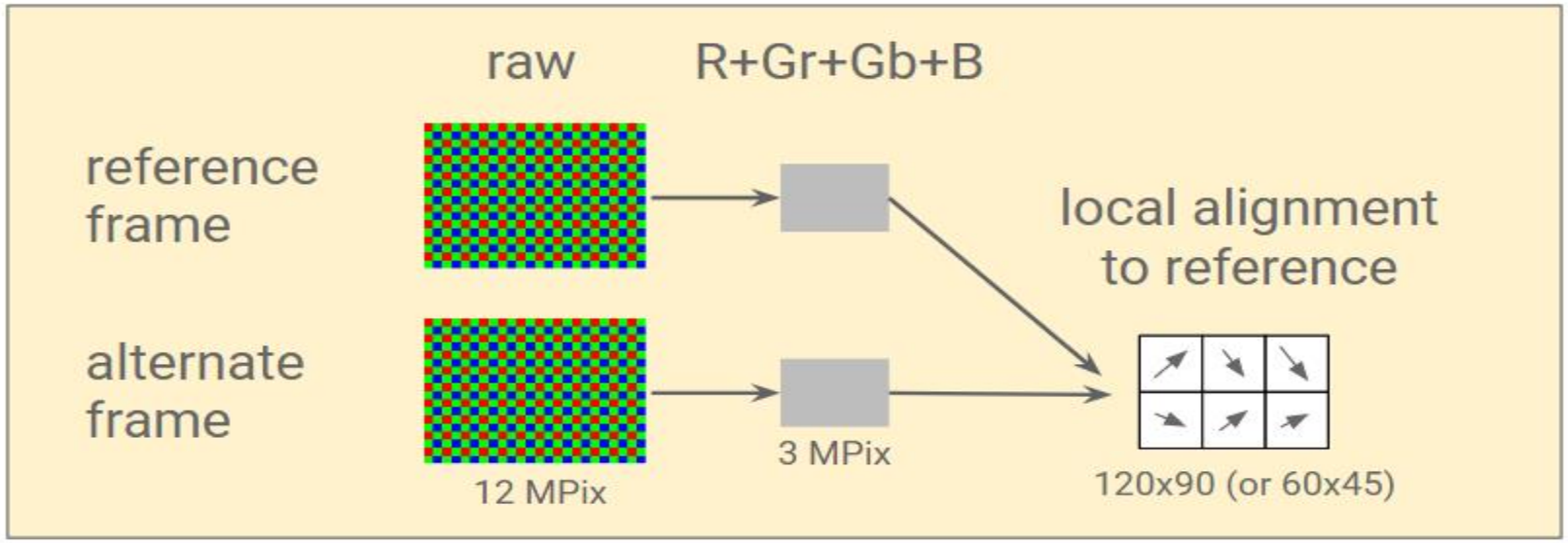


Burst Technology from Google

Burst alignment

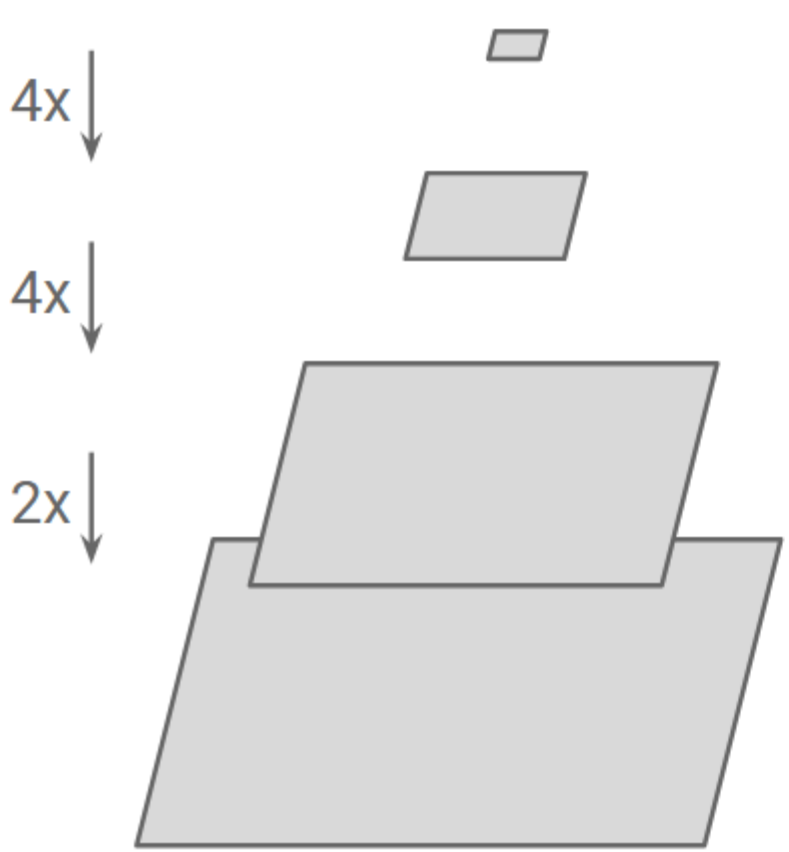
input burst

reference frame



Burst Technology from Google

Coarse to fine alignment



metric	search range	subpixel?
L2	9x9	yes
L1	3x3	no

- 4 pyramid levels
- upsample with multiple hypotheses [Tao et al., 2012]

Burst Technology from Google

Example alignment

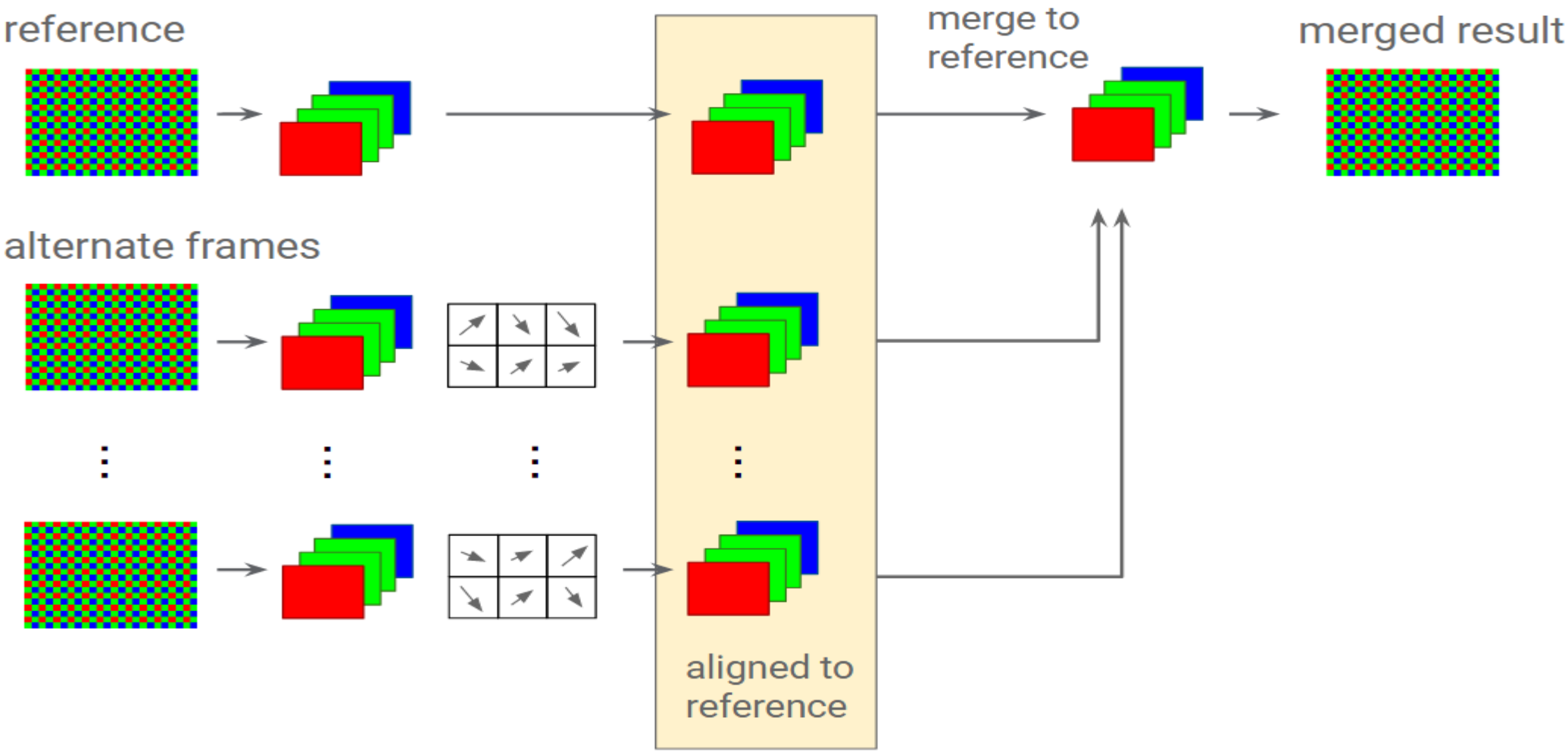
reference frame


aligned to reference


Burst Technology from Google

Merge overview

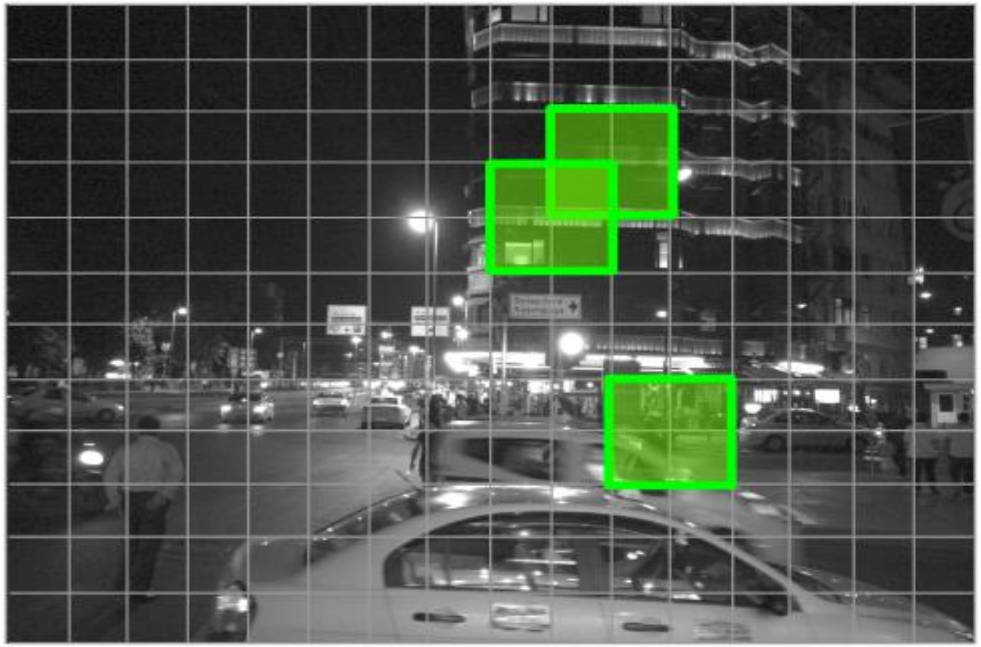
- apply the same alignment to each color channel
- merge color channels independently

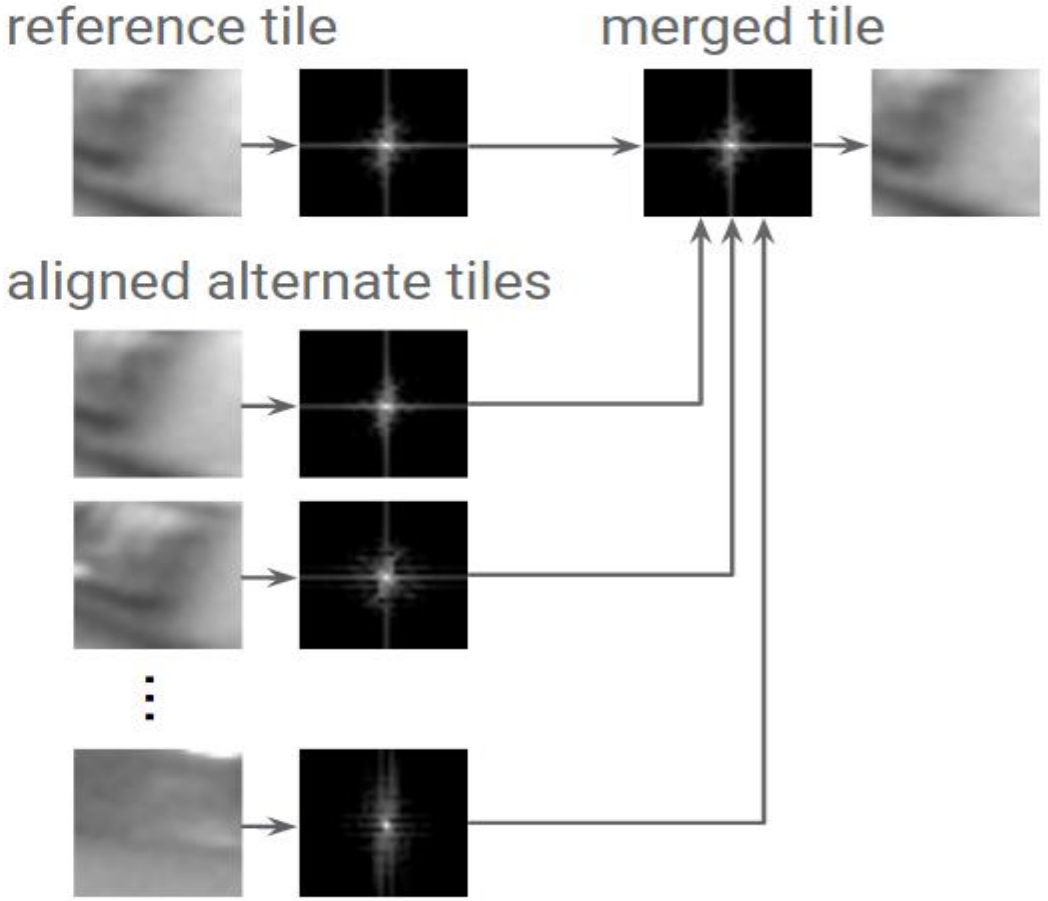


Burst Technology from Google

Tiled Fourier-based merge

- divide into 16x16 or 32x32 tiles
  - 50% overlap - every pixel covered by 4 tiles
- merge in Fourier domain





Burst Technology from Google

Robust per-frequency merge

reference frame

$$T_0$$

aligned average

$$\frac{1}{N}\sum T_i$$

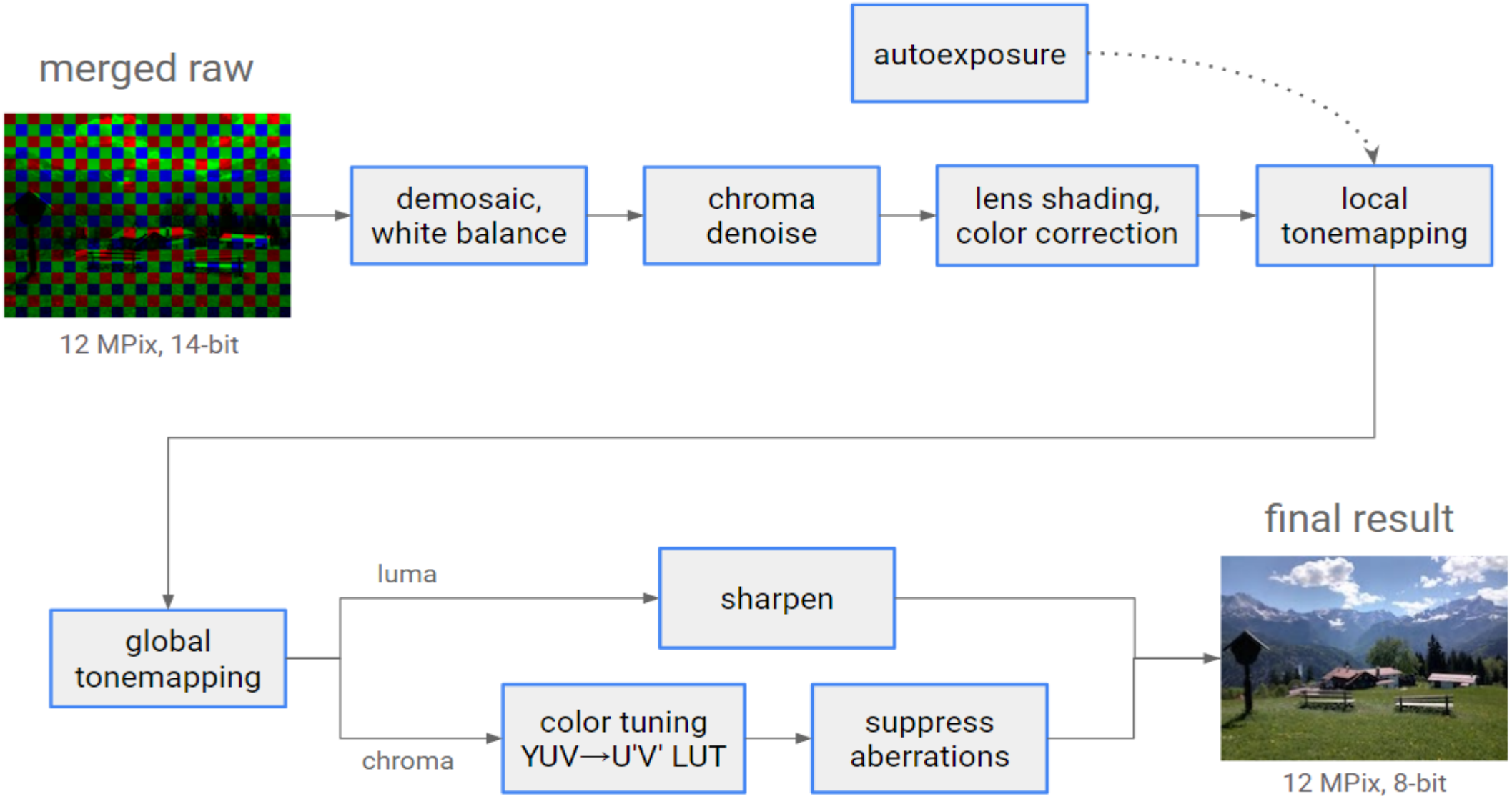
robust pairwise merge

$$\frac{1}{N}\sum (1 - A_i)\, T_i + A_i\, T_0$$

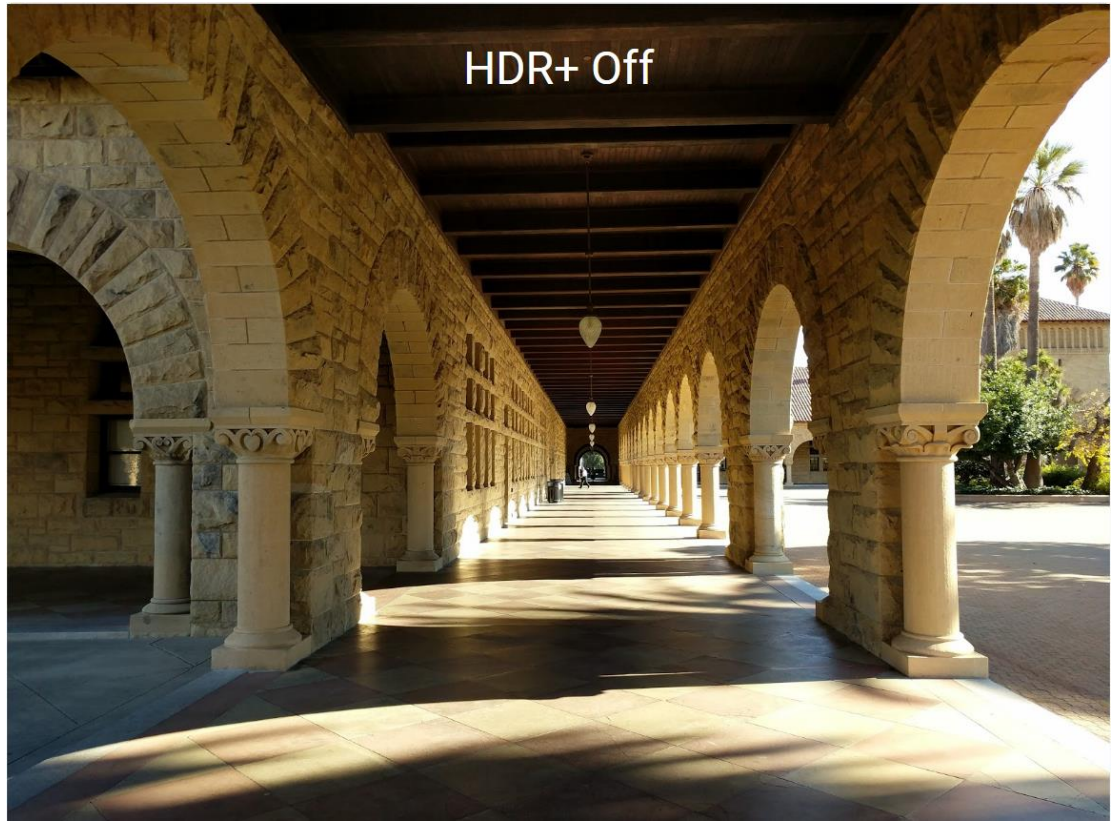
$$A_i = \frac{||T_0 - T_i||^2}{||T_0 - T_i||^2 + k\sigma^2} \in [0, 1]$$

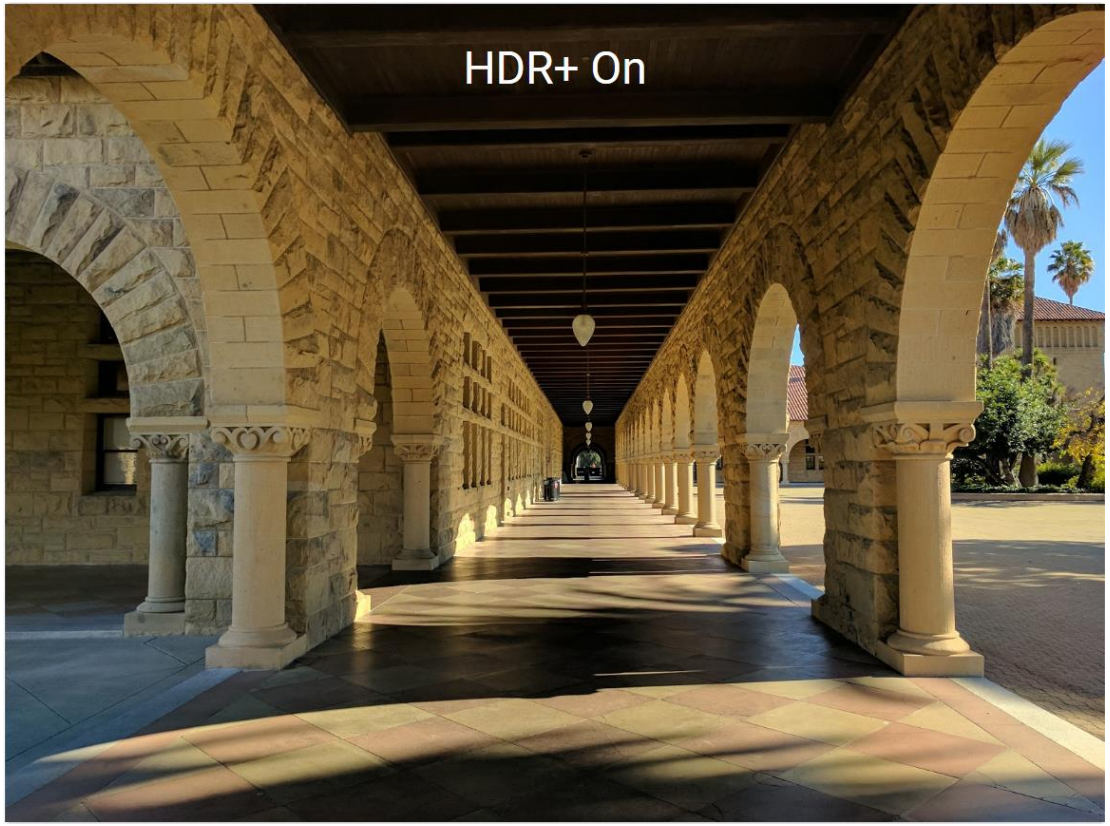
Burst Technology from Google

Finish pipeline



Burst Technology from Google





Burst Technology from Google