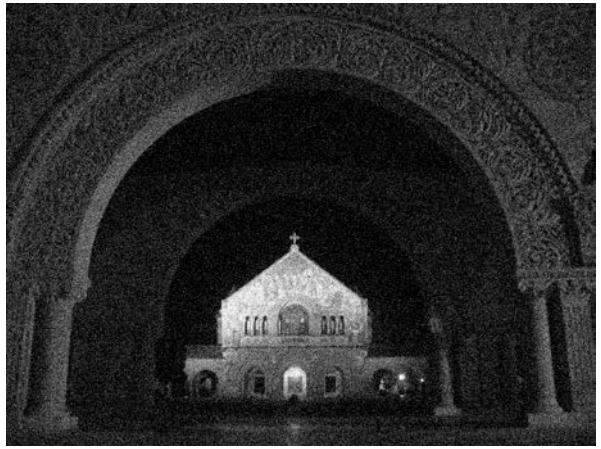
Point operations for combining images

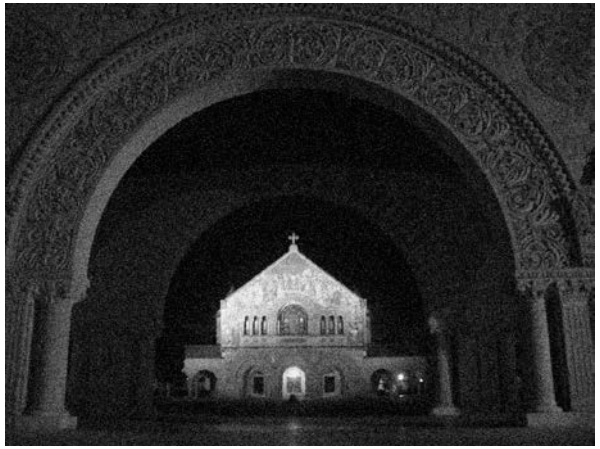
- Image averaging for noise reduction
- Combination of different exposures for high-dynamic range imaging
- Image subtraction for change detection
- Need for accurate alignment

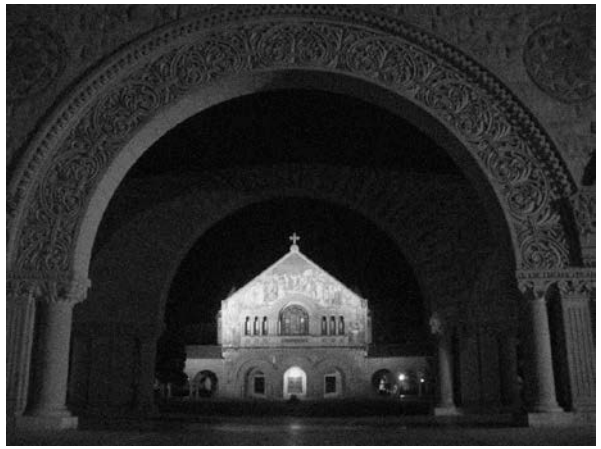
Image averaging for noise reduction

1 image



2 images





8 images

32 images

If we average N corresponding images (taken at different times), by what factor does the noise variance decrease?

(a) $\frac{1}{N^2}$ (b) $\frac{1}{N}$ (c) $\frac{1}{\sqrt{N}}$

High-dynamic range imaging

-8 f-stops

-2 f-stops

+2 f-stops

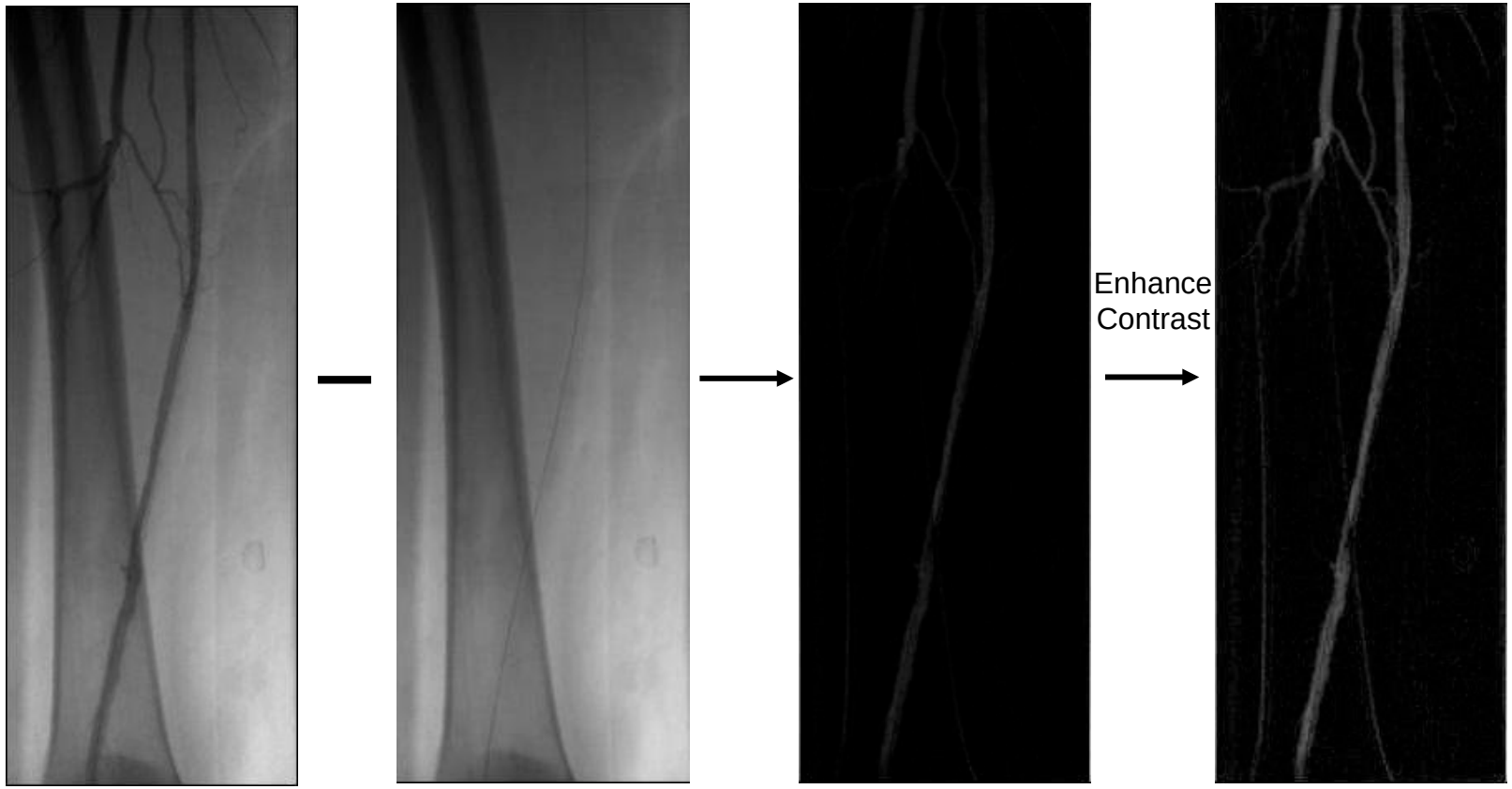
+4 f-stops

Blended image from Exposure Fusion

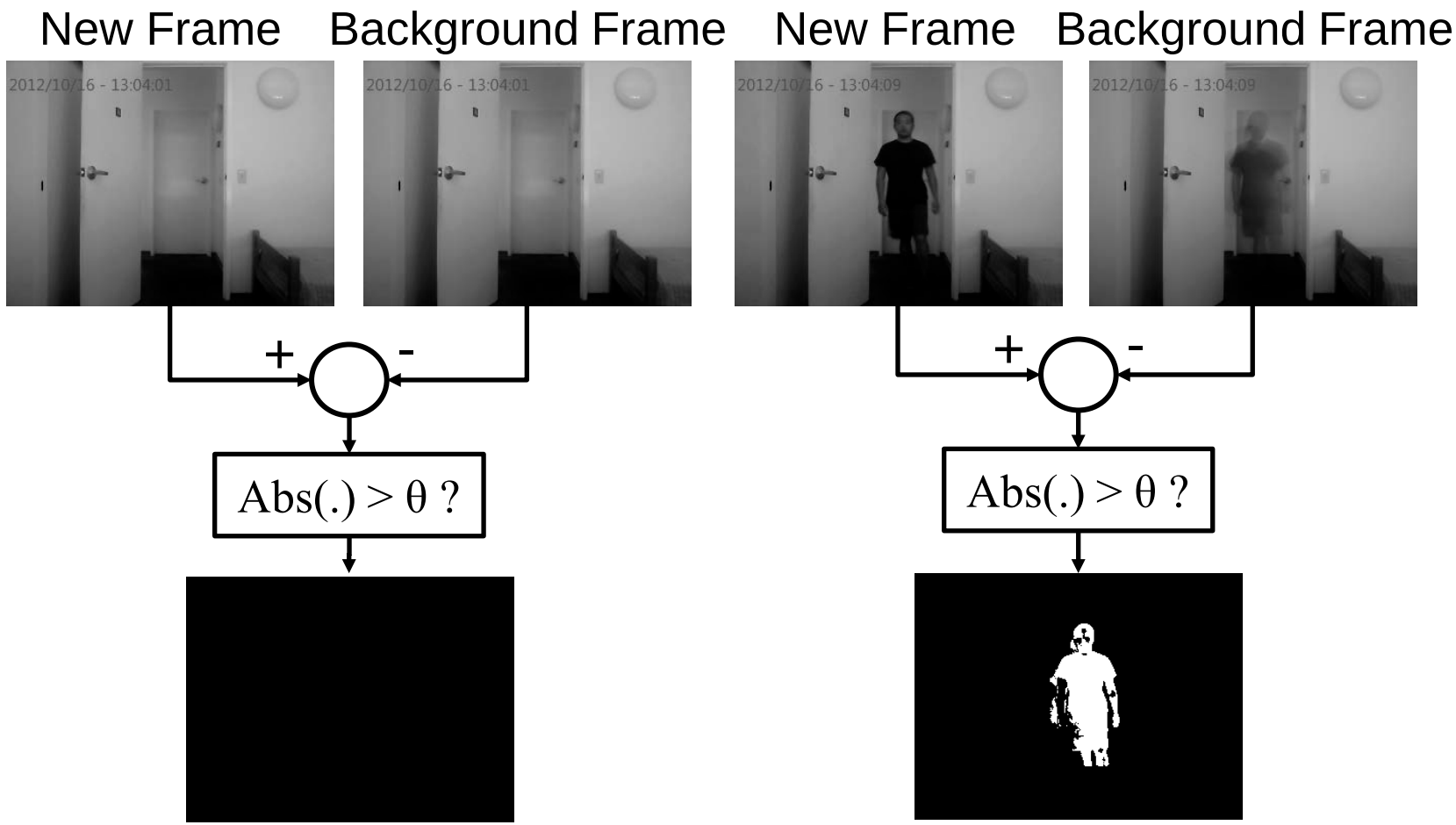
[Tom Mertens et al. 2007]

Image subtraction

- Find differences/changes between 2 mostly identical images
- Example: digital subtraction angiography



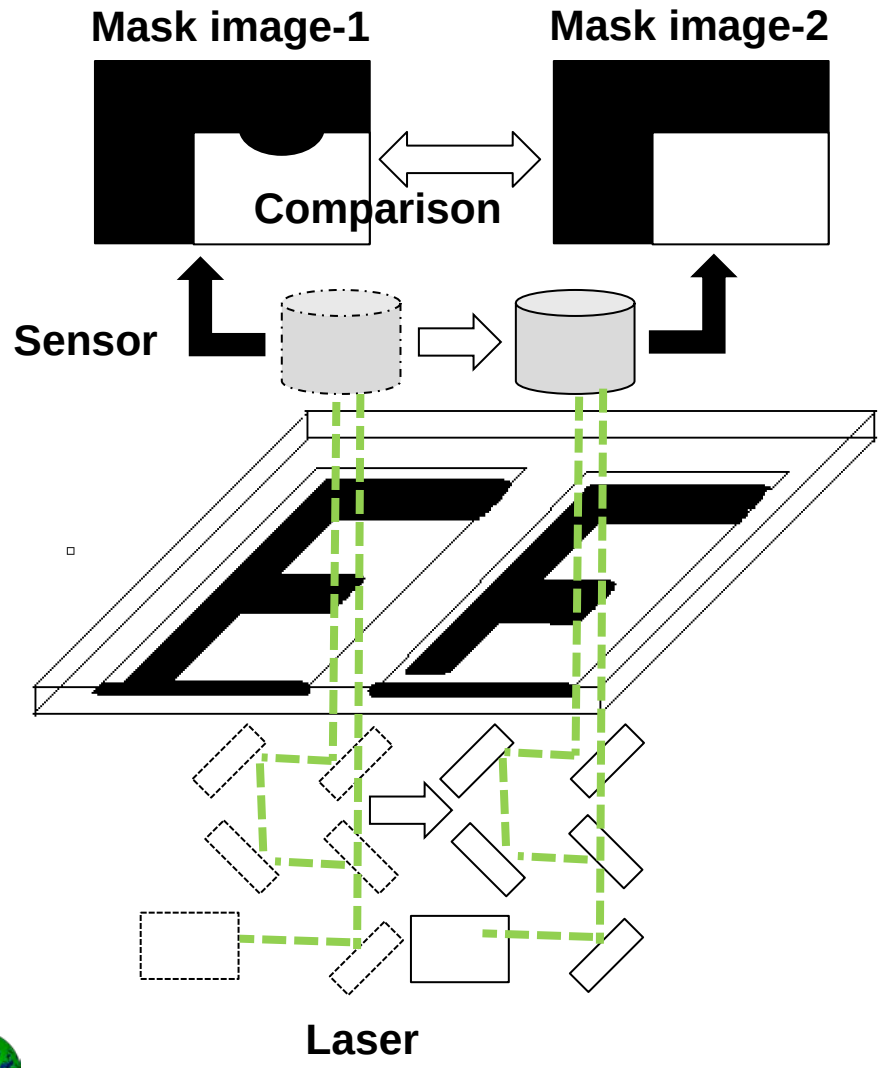
Video background subtraction

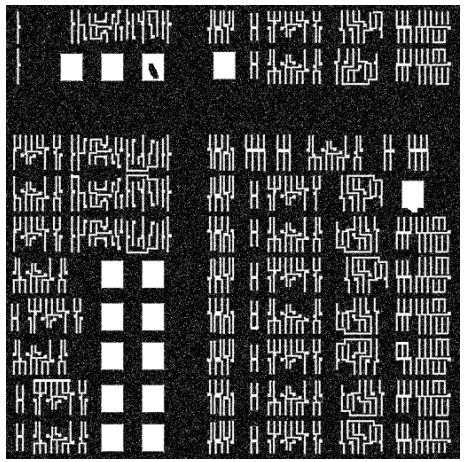


Update:

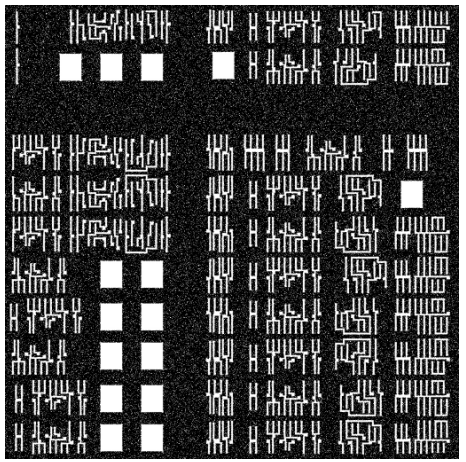
Background[t] := α Background[t-1] + (1- α) New[t]

Image subtraction in IC manufacturing: inspection of photomasks





Mask image-1



Mask image-2

Difference image

Where is the defect?

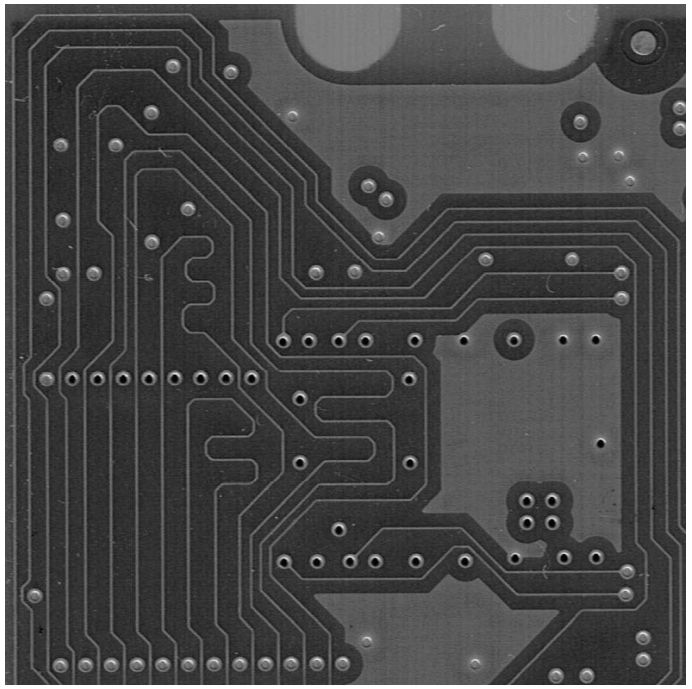


Image $g[x,y]$ (no defect)

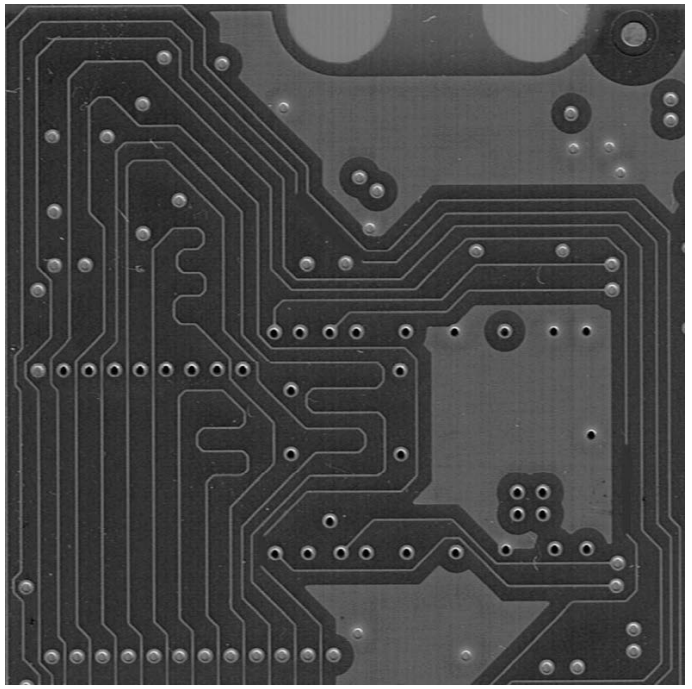
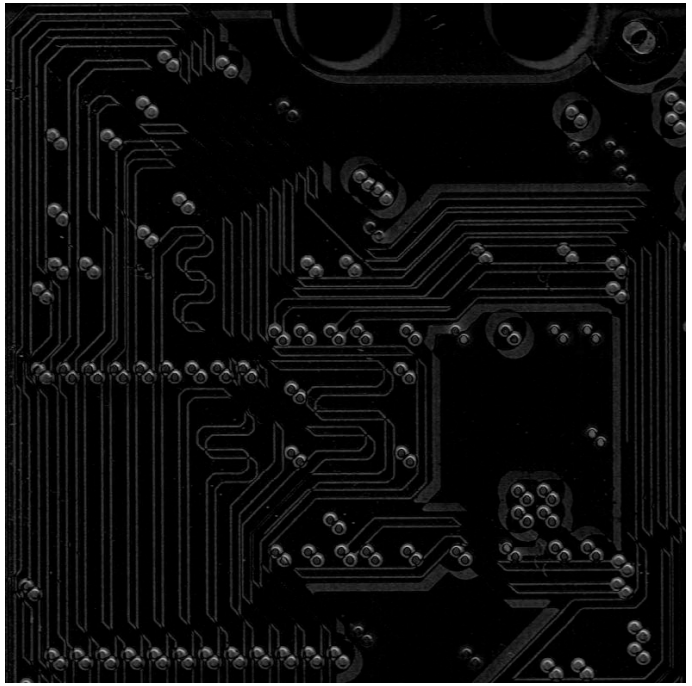
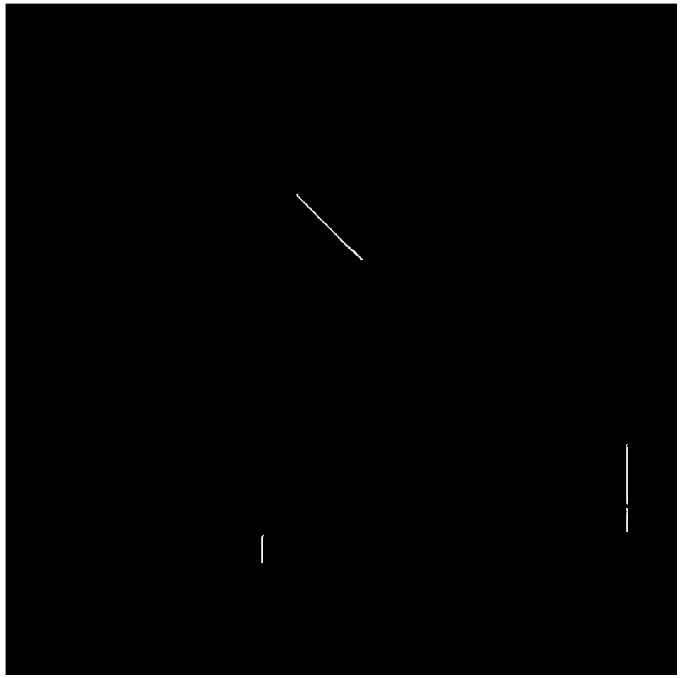


Image $f[x,y]$ (w/ defect)

Absolute difference between two images



$|f\text{-}g|$ w/o alignment



$|f\text{-}g|$ w/ alignment

???