

# Methods of Camera Noise Reduction for Digital Mobile Devices

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# Agenda

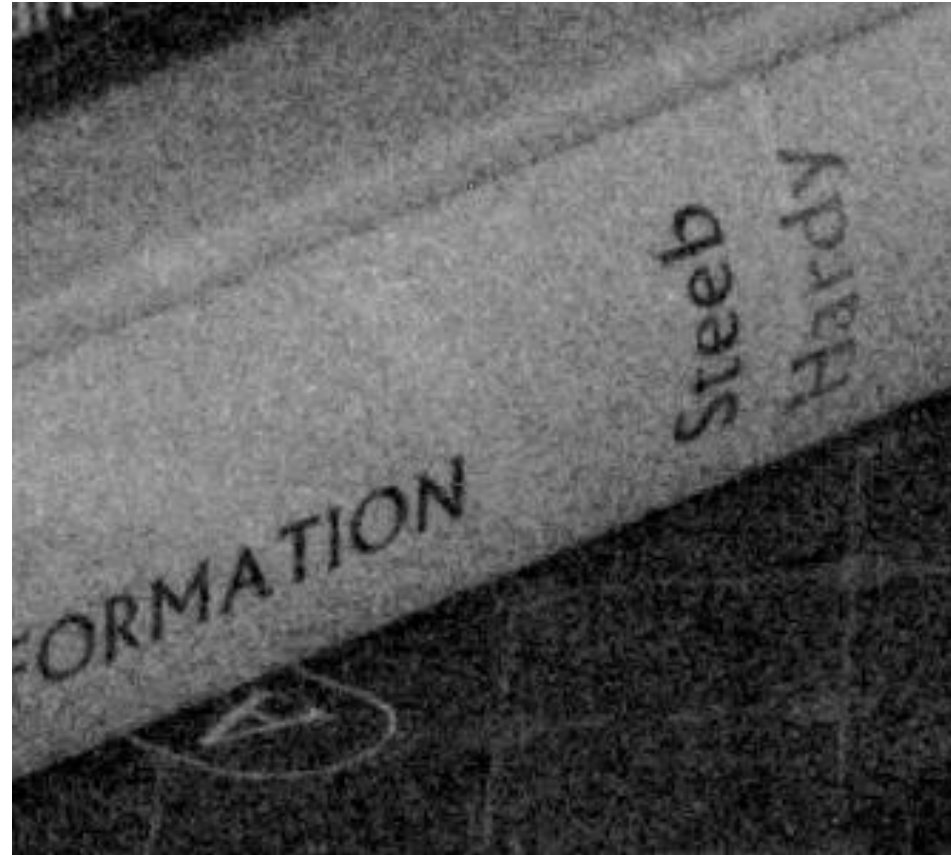
- Camera Noise Overview
- Methods of Camera Noise Reduction
- Proposed Method Description
- Comparison of Methods
- Plans for Future

# Noise Types

Image lossy encoding



Camera noise



# Sources of Camera Noise

- Error in charge accumulation (including thermal noise)
- Quantization noise
- Amplifying noise

# Noise Reduction Methods

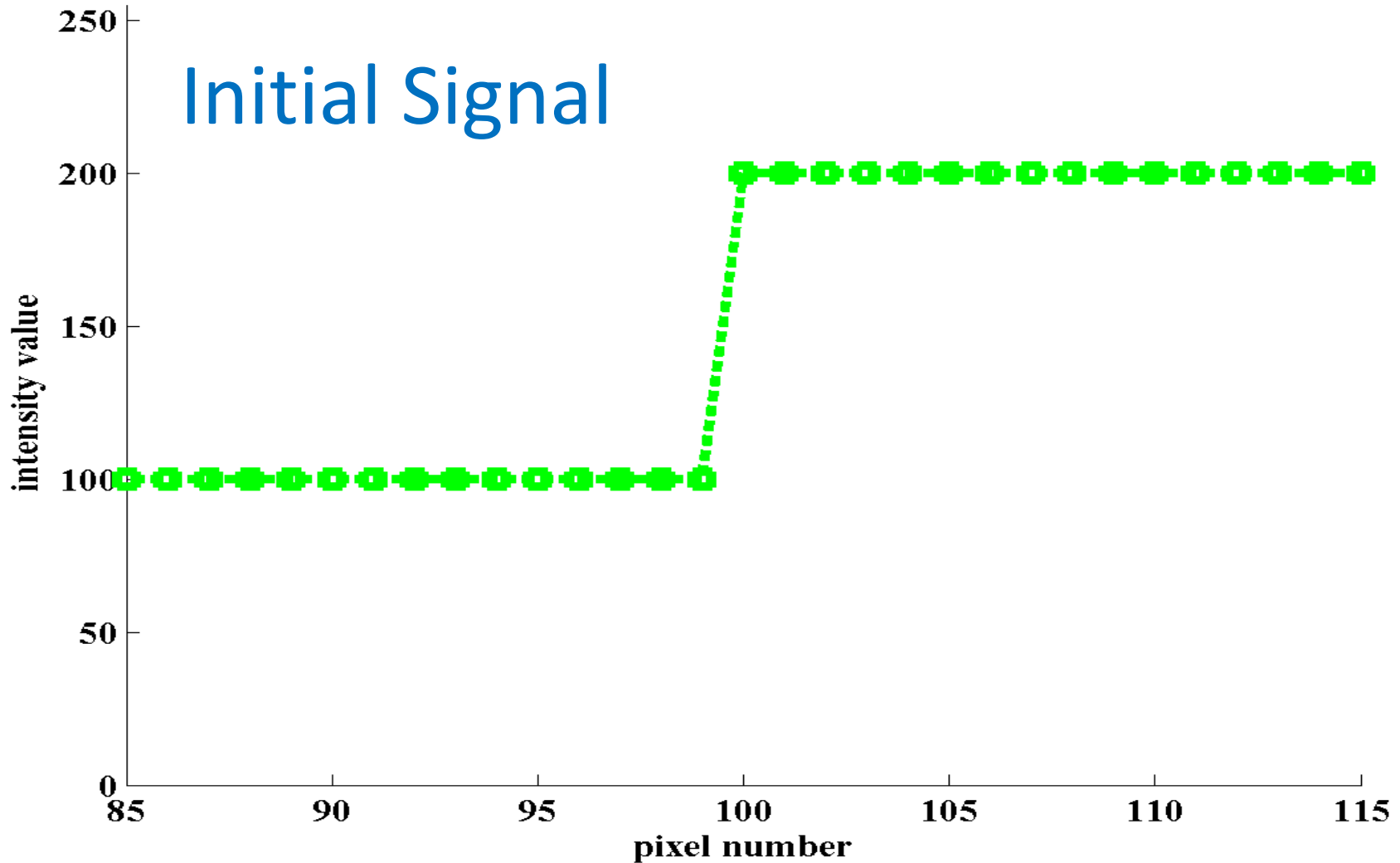
## Non-adaptive methods

- Averaging Filtering
- Gaussian Filtering
- Median Filtering
- Etc.

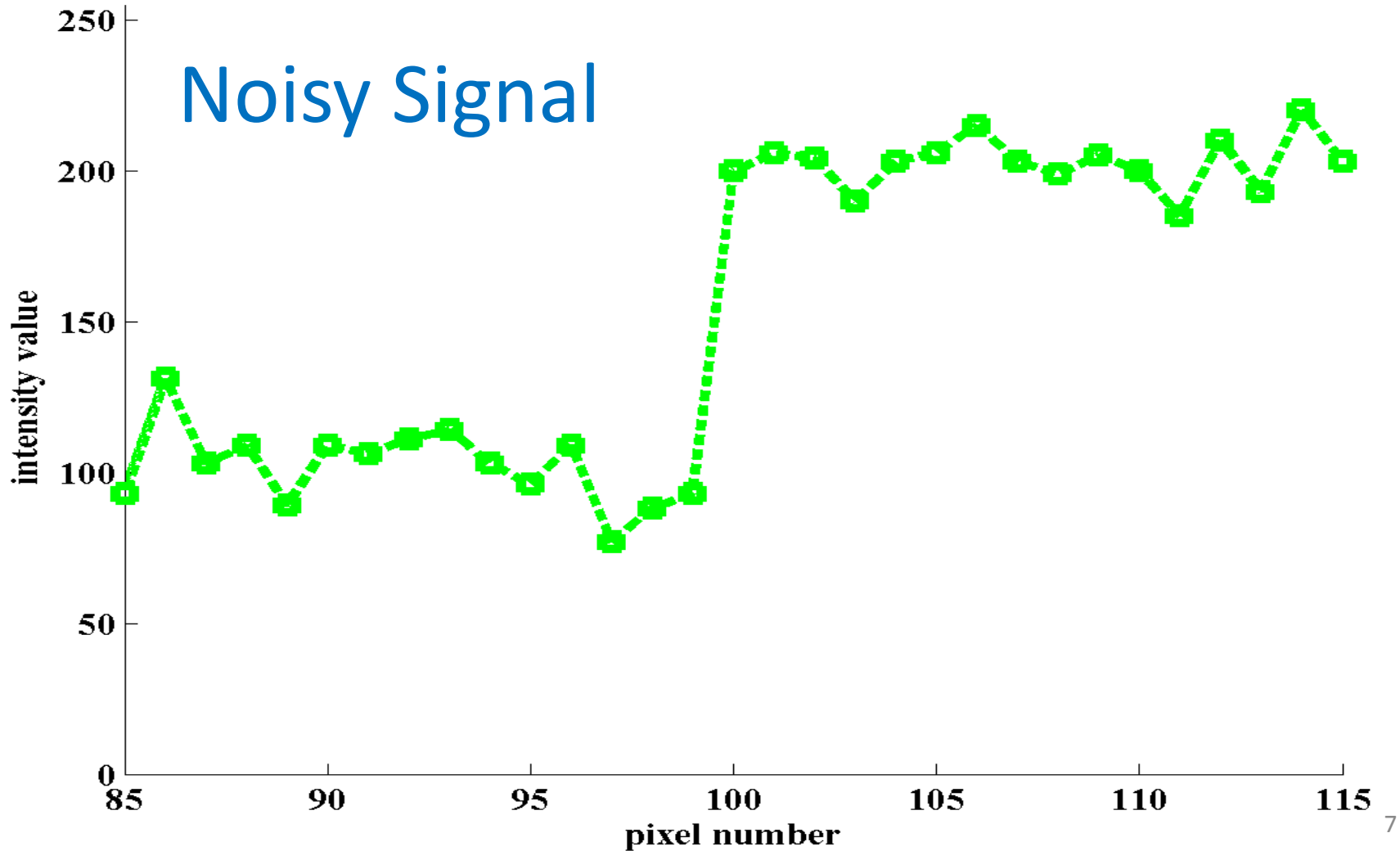
## Adaptive methods

- Adaptive Averaging Filtering
- Adaptive Gaussian Filtering
- Proposed filter
- Etc.

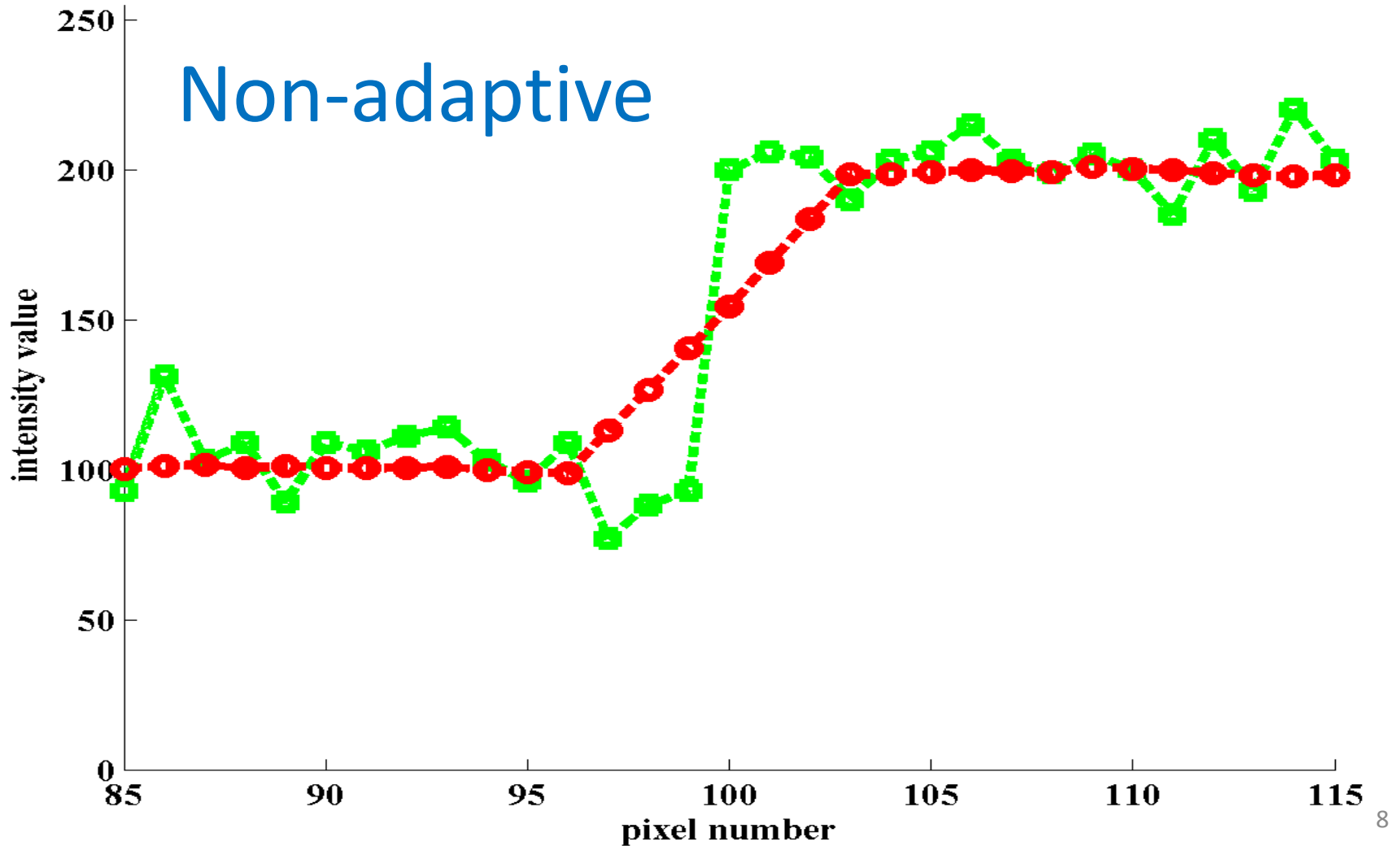
# Adaptive vs. Non-adaptive Methods



# Adaptive vs. Non-adaptive Methods

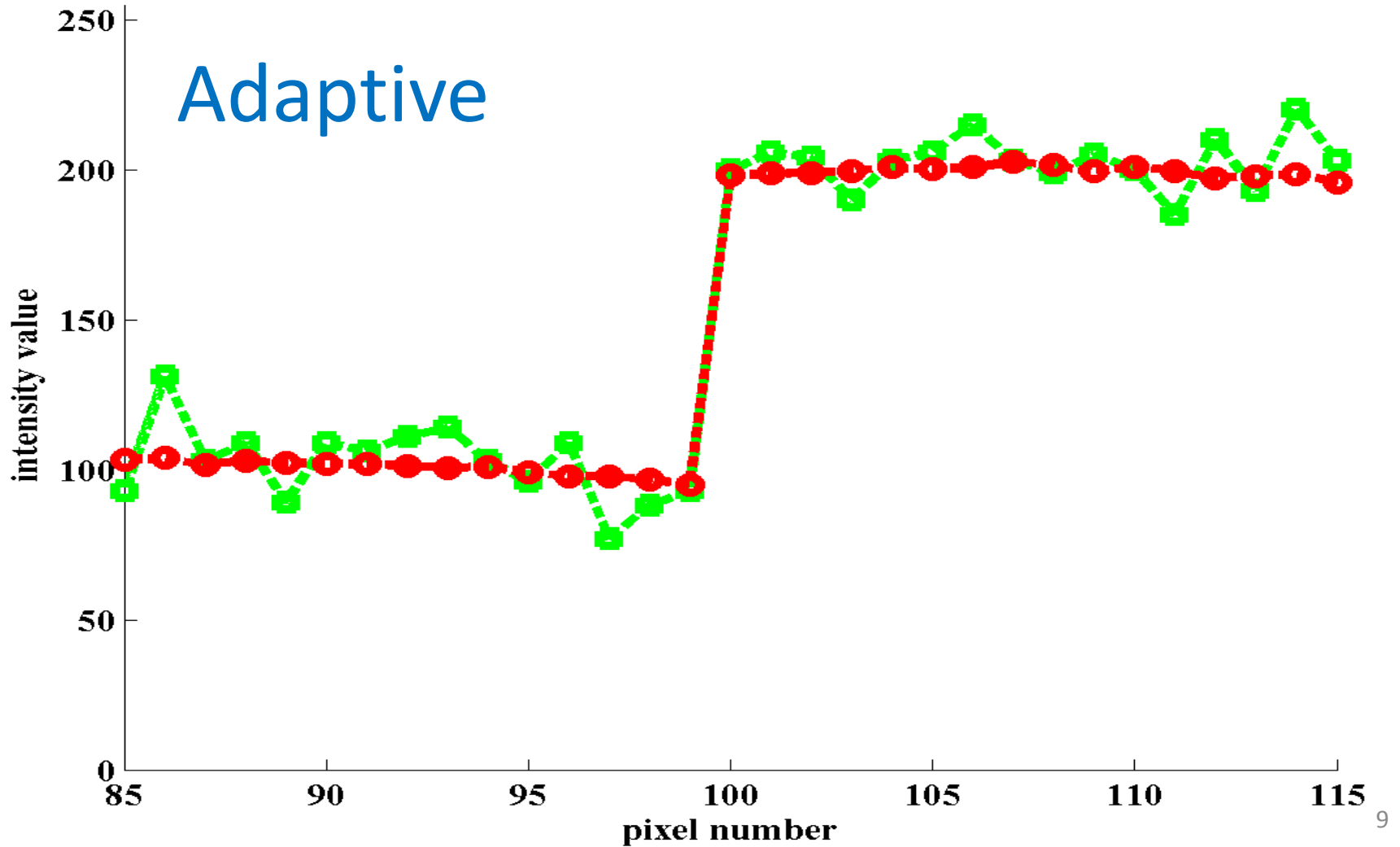


# Adaptive vs. Non-adaptive Methods





# Adaptive vs. Non-adaptive Methods



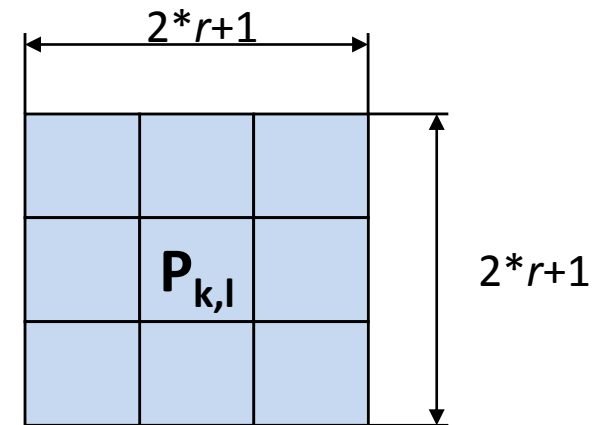
# Proposed Filter Description

- For a pixel  $p(k,l)$  of noisy image the filter calculates the filtered pixel value  $p'(k,l)$  using the following formulae:

$$p'(k,l) = \frac{\sum_{i=-r}^r \sum_{j=-r}^r p(k+i, l+j) * w(i+r, j+r)}{\sum_{i=-r}^r \sum_{j=-r}^r w(i+r, j+r)}$$

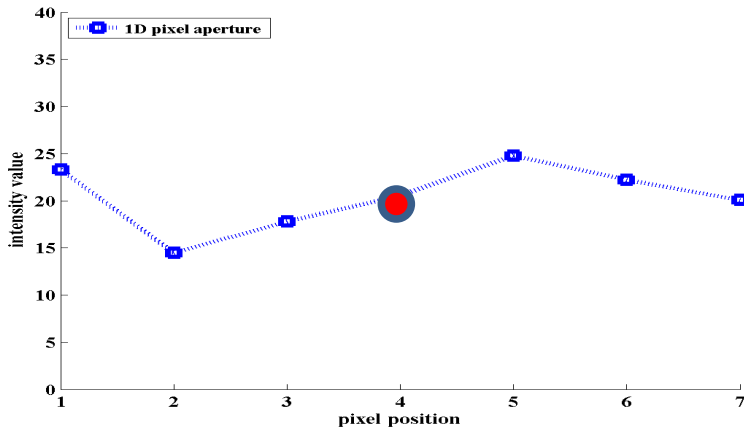
where

$$w(i+r, j+r) = \begin{cases} wC, & \text{if } i=0, j=0 \\ 0, & \text{if } wR - |p(k,l) - p(k+i, l+j)| < 0, i \neq 0, j \neq 0 \\ wR - |p(k,l) - p(k+i, l+j)|, & \text{otherwise} \end{cases}$$

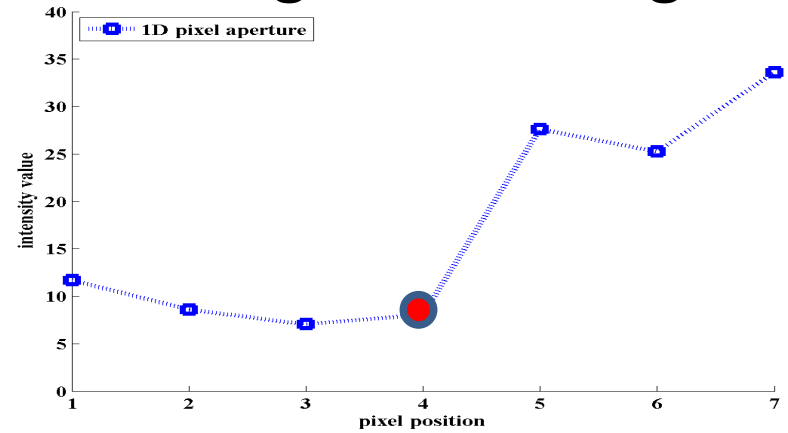


# Weight Coefficients for Specific Regions (1D Case)

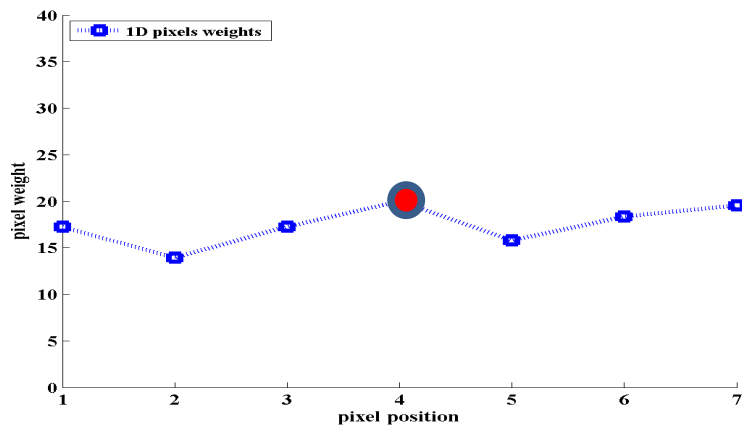
## Flat region



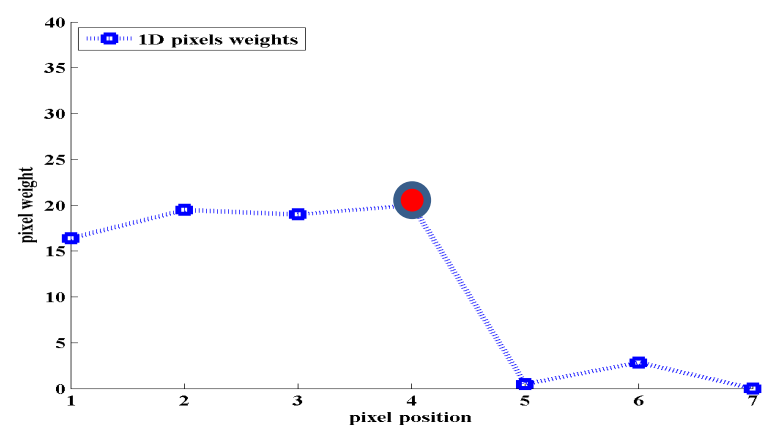
## Region with edge



## Weights for Flat Region



## Weights for Region with Edge

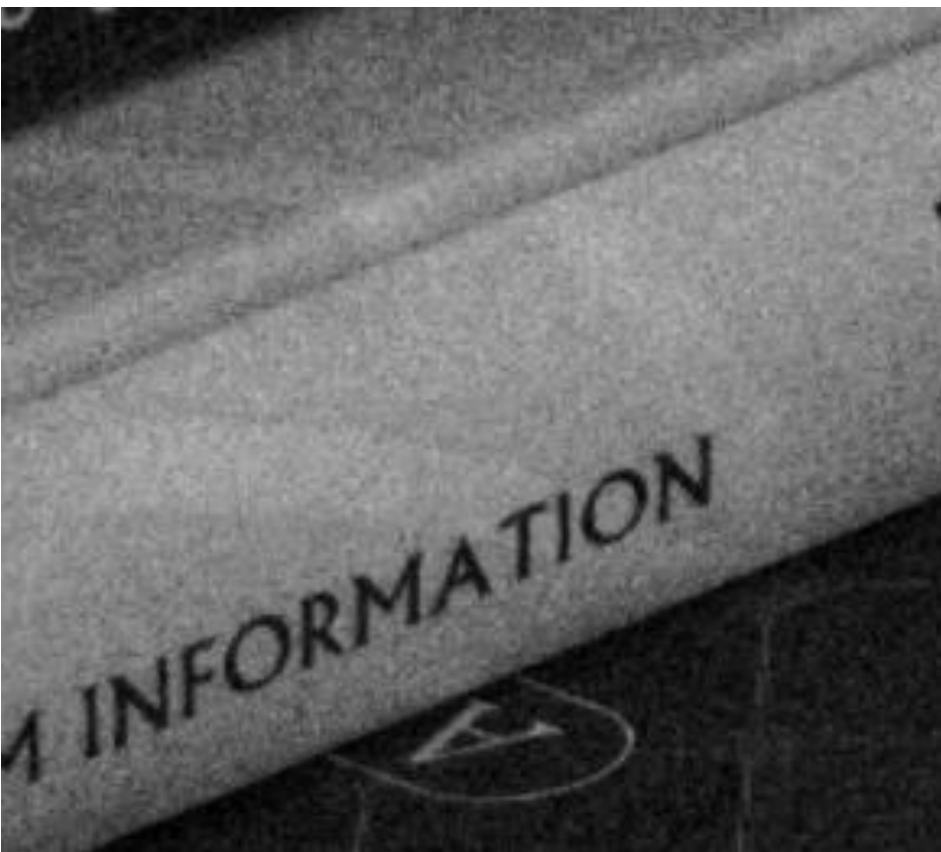


# Compared Methods

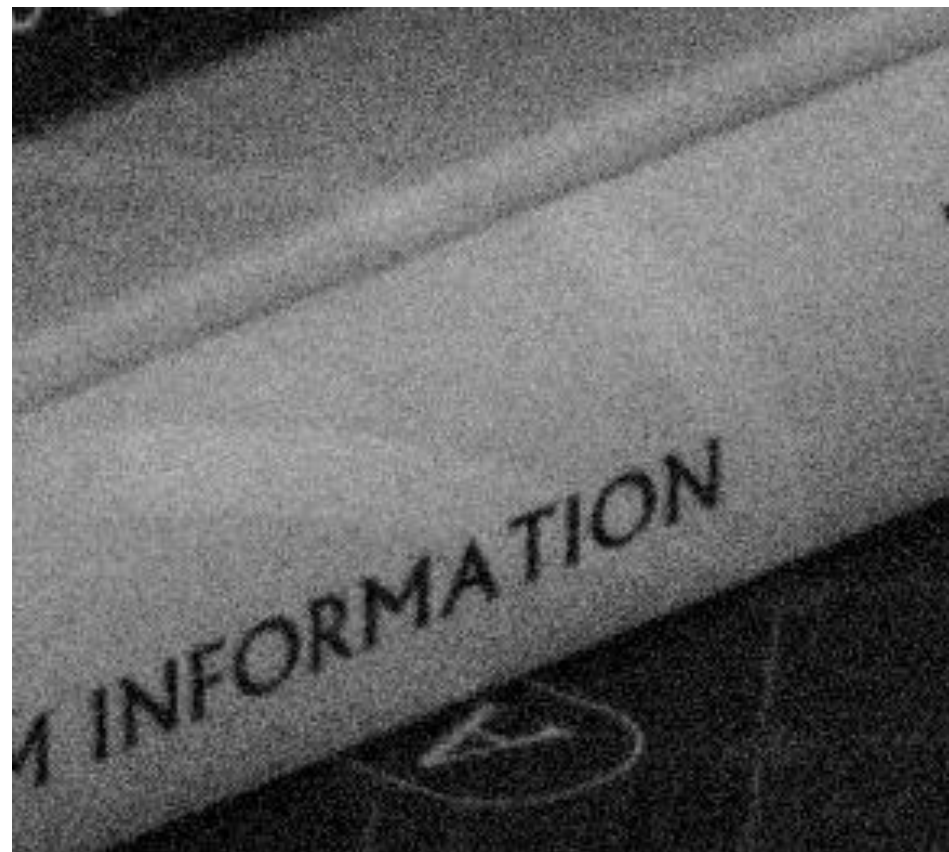
- “Smooth” filter from Gimp
- “Denoise” filter from Photoshop
- Filters from “Akvis Noise Buster”
- Adaptive Filters (Gaussian, average)
- Proposed filter

# Noise Modeling

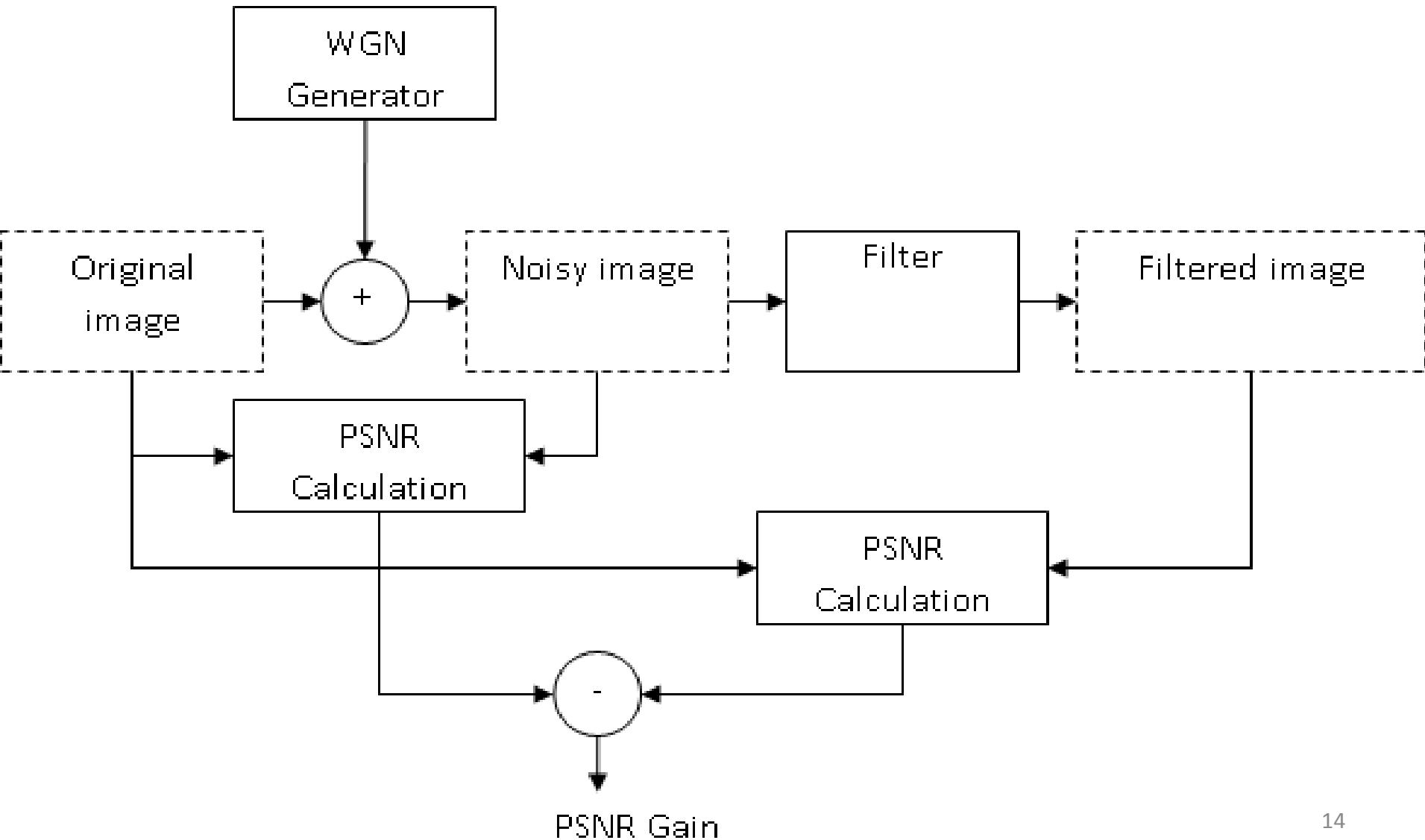
Camera Noise



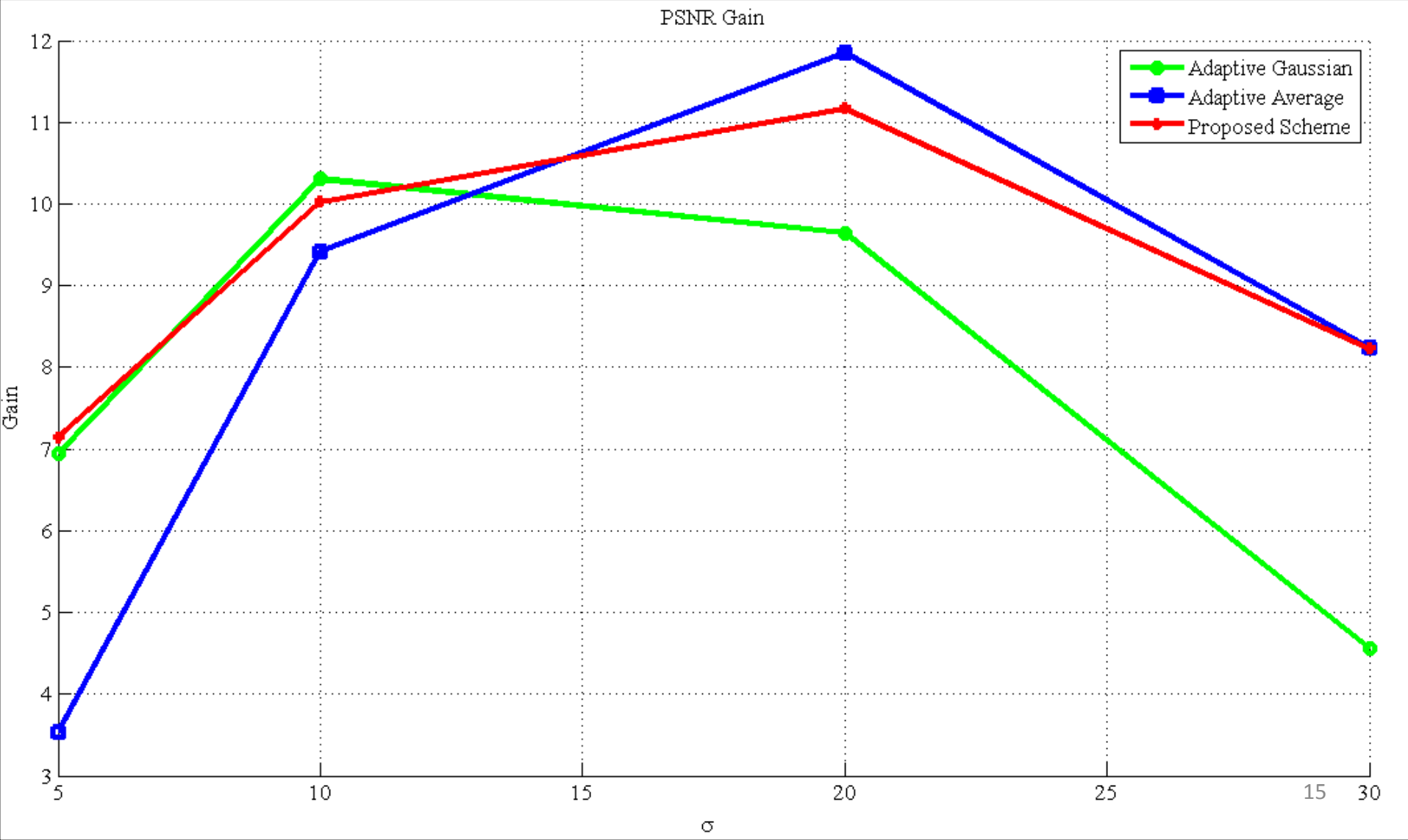
Gaussian Noise



# Experiment Plan



# PSNR Gain Comparison for Adaptive Methods



# Comparison with Graphics Packages

Filter	PSNR Gain (sigma = 20: PSNR=22 dB)
Proposed Filter	10
Adobe Photoshop	8.1
Akvis Noise Buster	7.8
Paint.Net	8.2



# Future Work

- Improvement of quality metrics for camera noise estimation
- Visual quality improvement (not PSNR)

Thank you for your attention.  
Questions?