

Detecting Tampered Image Regions

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Previous Work

2005

Determined that a digital image's origin can be identified.

2009

Determined that portions of an digital image can be identified as tampered.

Noise Sources

PRNU (Photoresponse Non-uniformity)

DSNU (Dark Signal Non-uniformity)

Shot Noise

Readout Noise

Quantization

Denoising & Noise Extraction

Flat Fielding

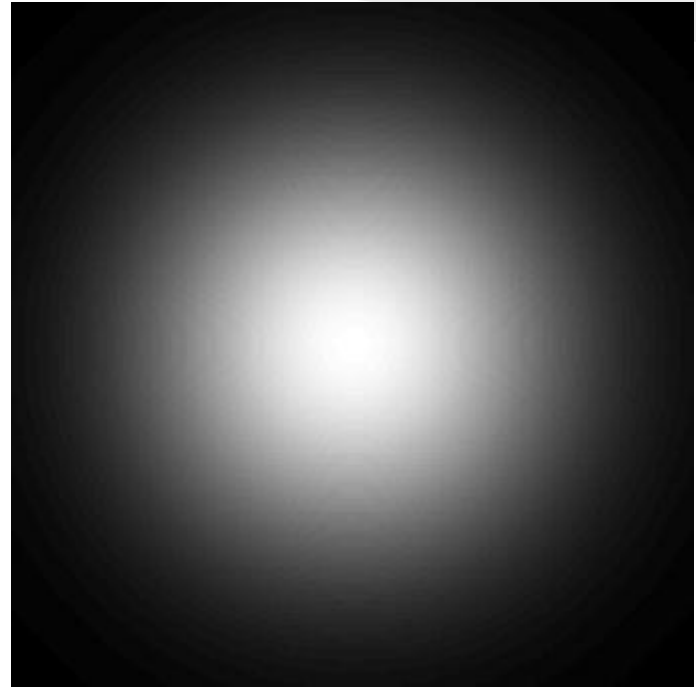
Filters for Estimation: Box, Median, Gaussian,
Bilateral, Bilateral Grid, ...

Denoising & Noise Extraction

Previous work used a combination of a Wiener filter and 8-tap Daubechies wavelet.

Gaussian Filter

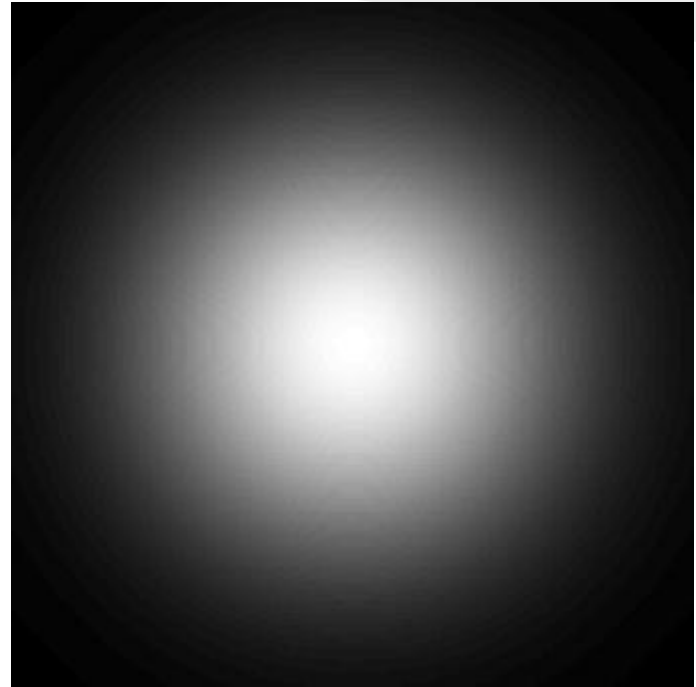
Smooth change in
dependency on
neighbors as the
distance increases



Bilateral Filter

Takes the pixel value
distance in account as
well as physical distance

$$B(x) = \frac{1}{k(x)} \sum_{\xi} f(x, \xi) g(I(\xi) - I(x)) I(\xi)$$



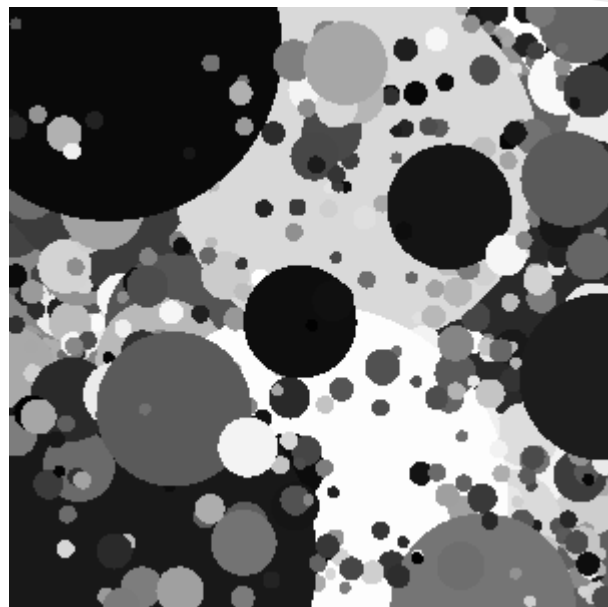
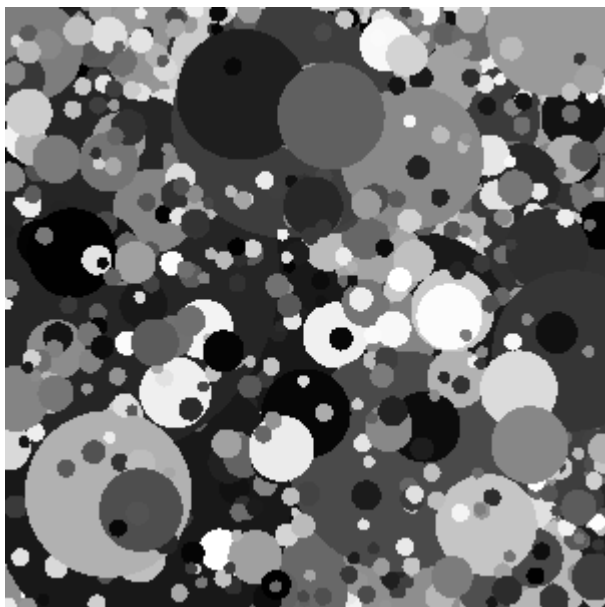
Modeling Cameras

Generate synthetic images

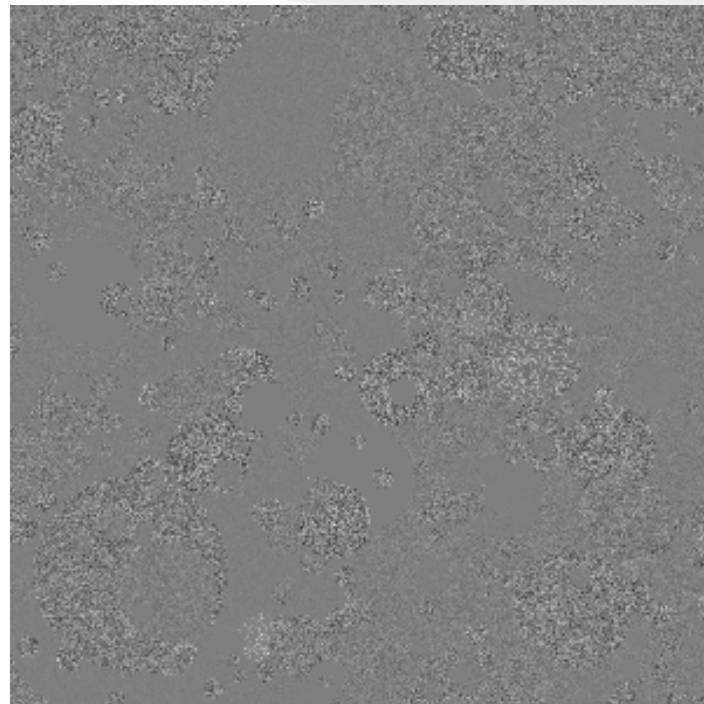
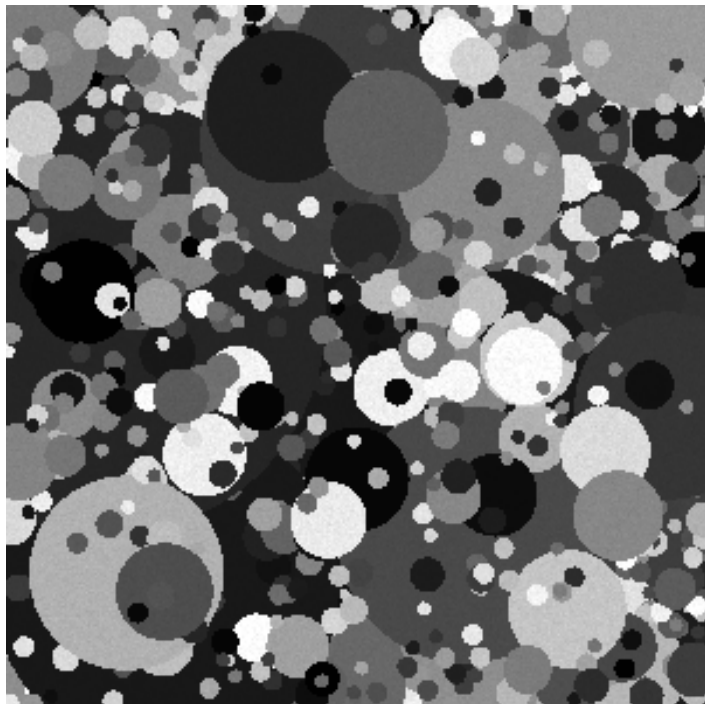
Model the noise sources

$$I = g^\gamma \cdot [(1 + K)Y + \Omega]^\gamma + Q$$

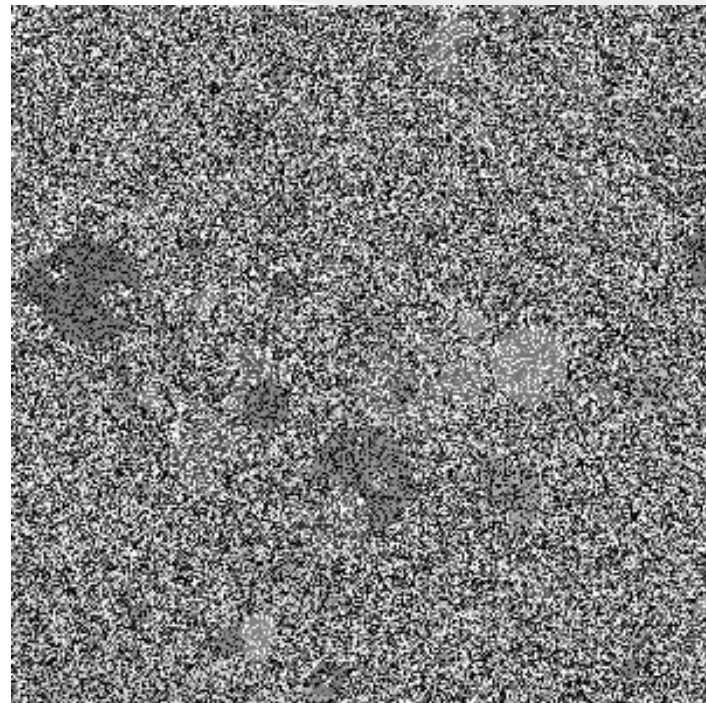
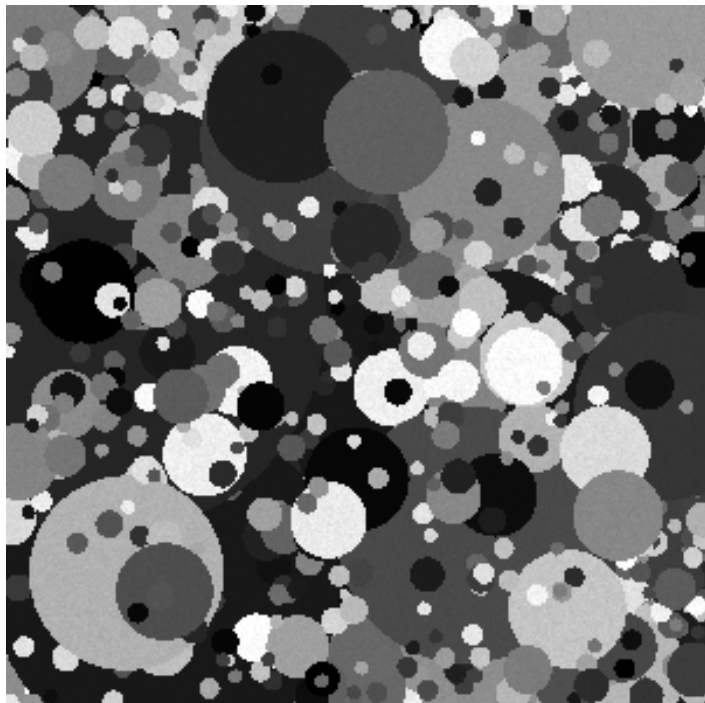
Deadleaf Images



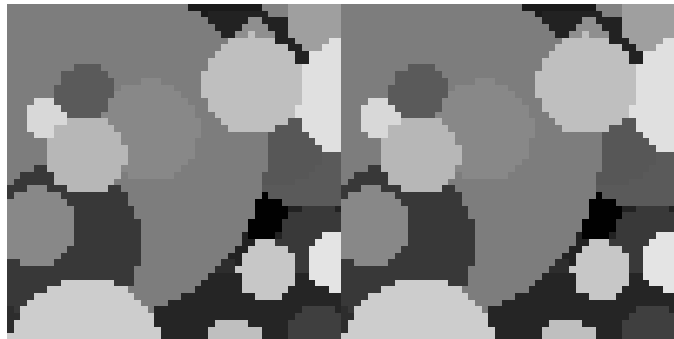
PRNU



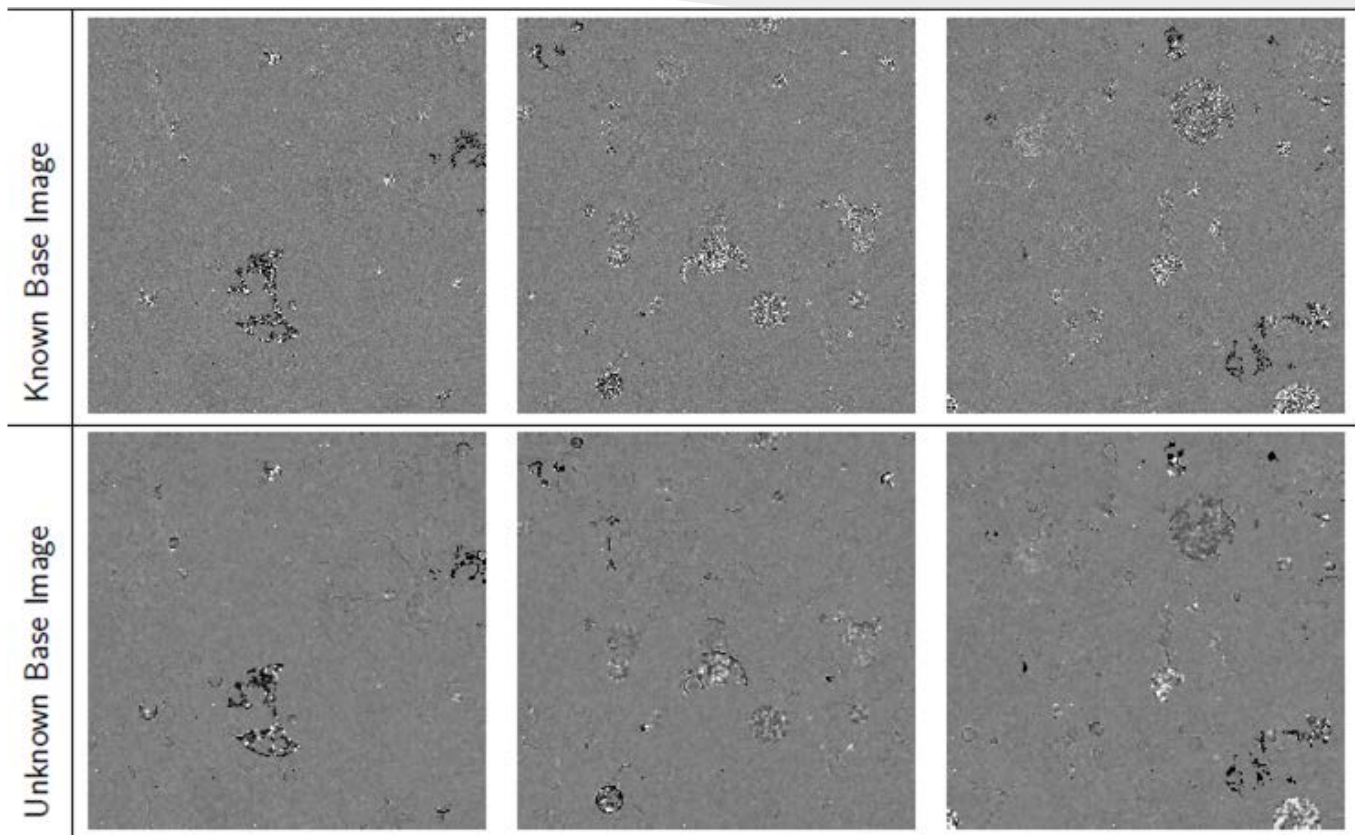
Gaussian Noise



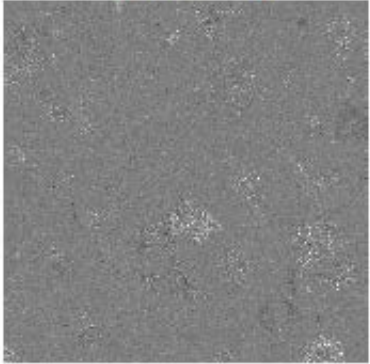
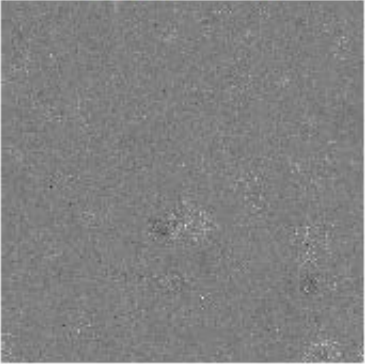
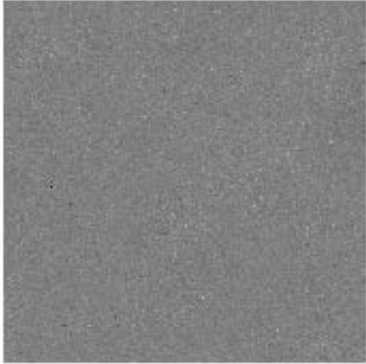
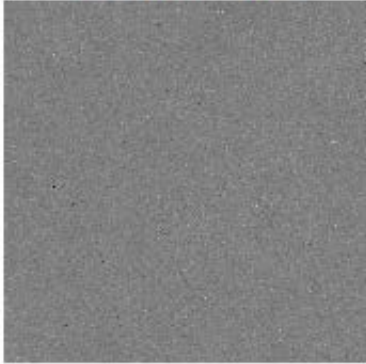
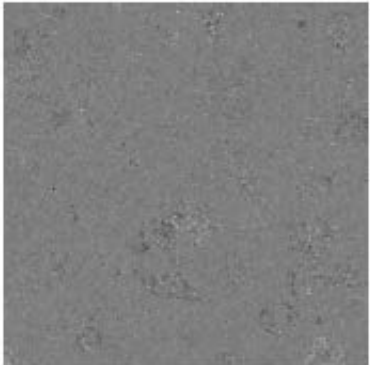
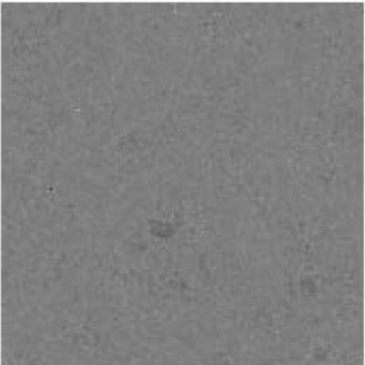
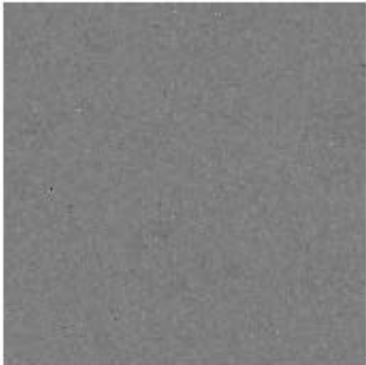
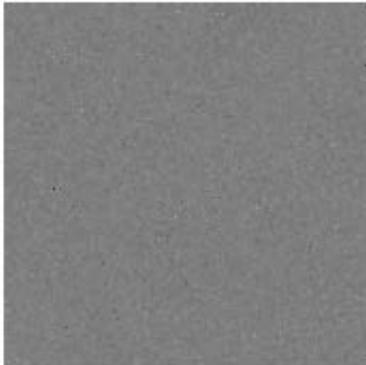
Quantization Noise



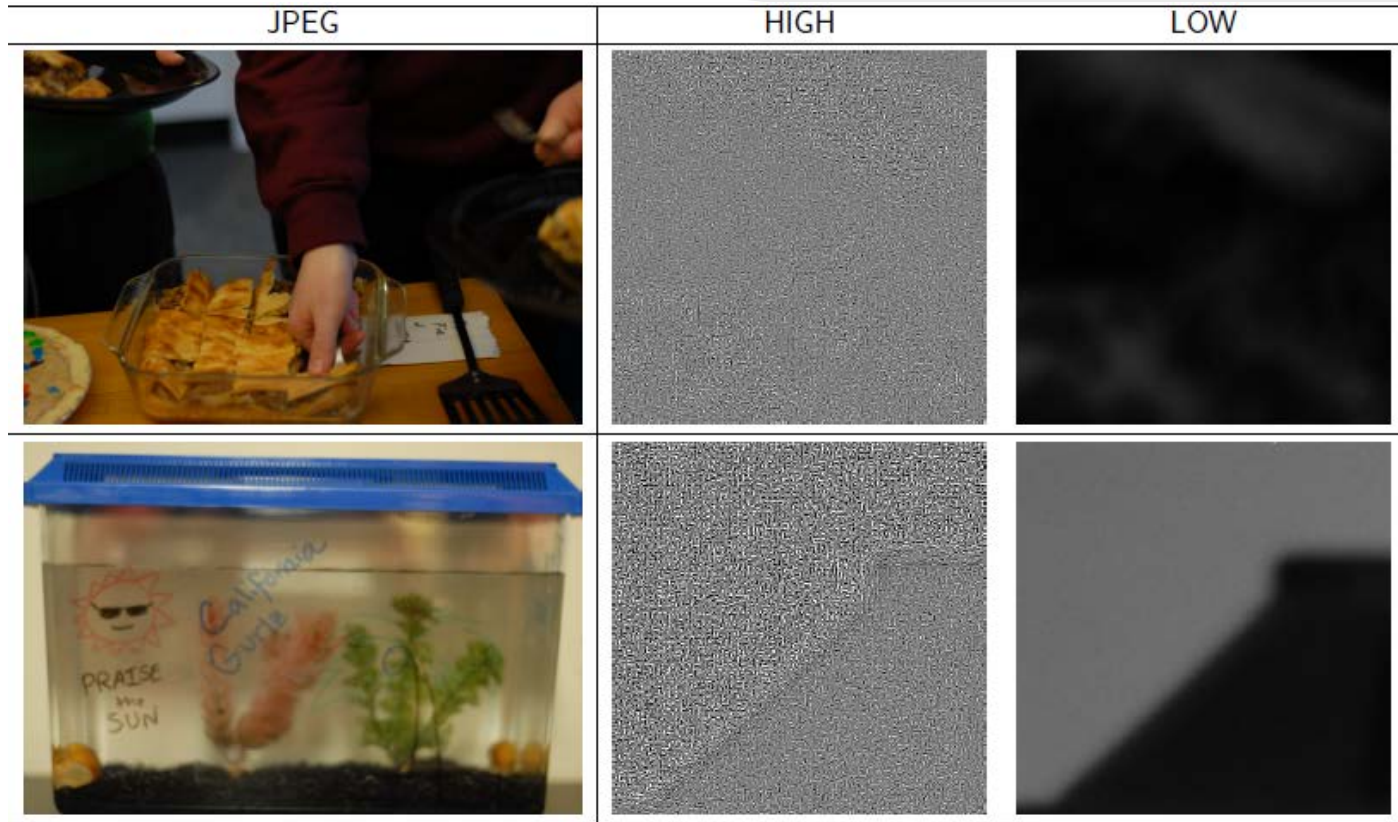
Extracting K



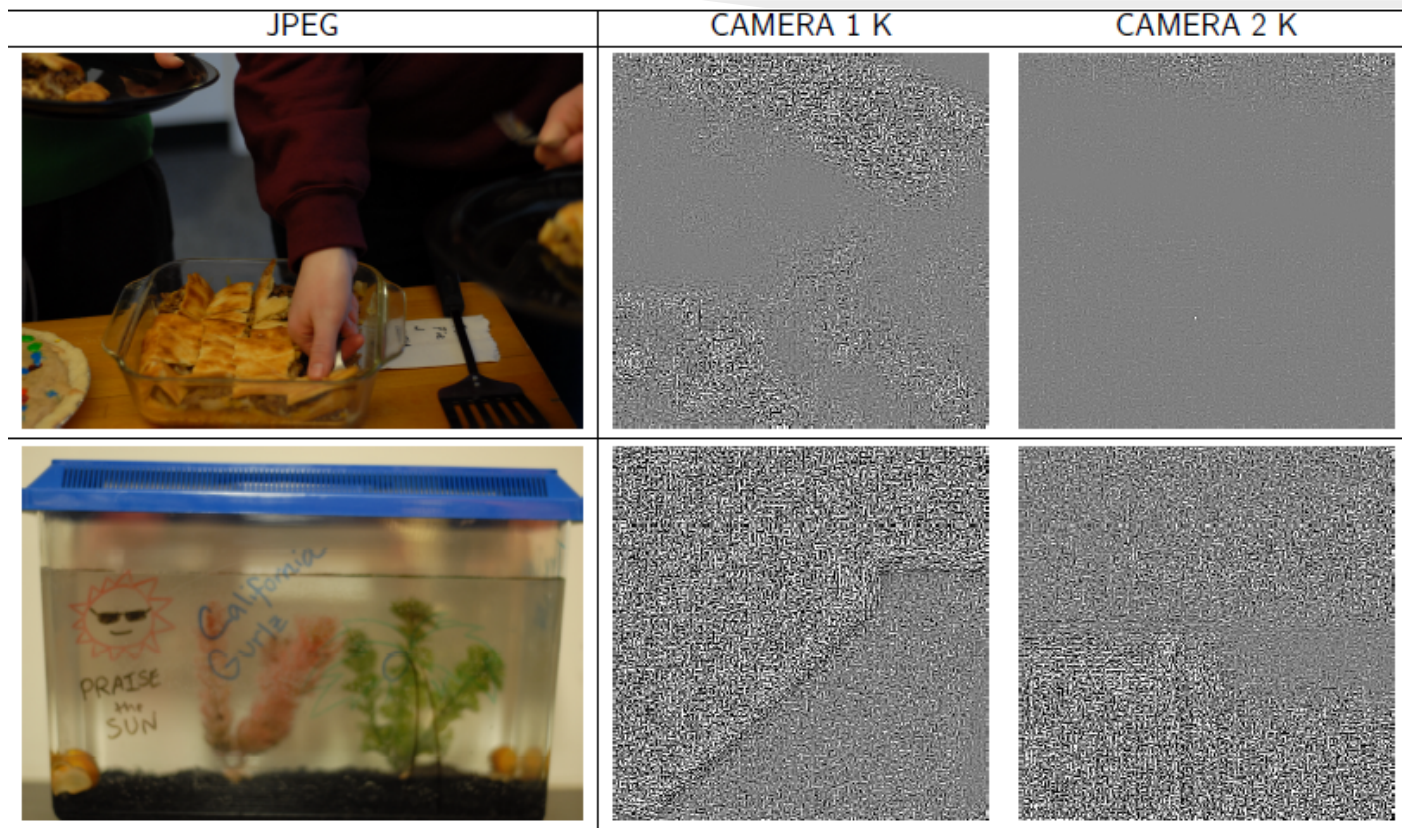
Averaging K

	NUM = 5	NUM = 10	NUM = 25	NUM = 50
Known Base Image				
Unknown Base Image				

D200 Images Frequencies

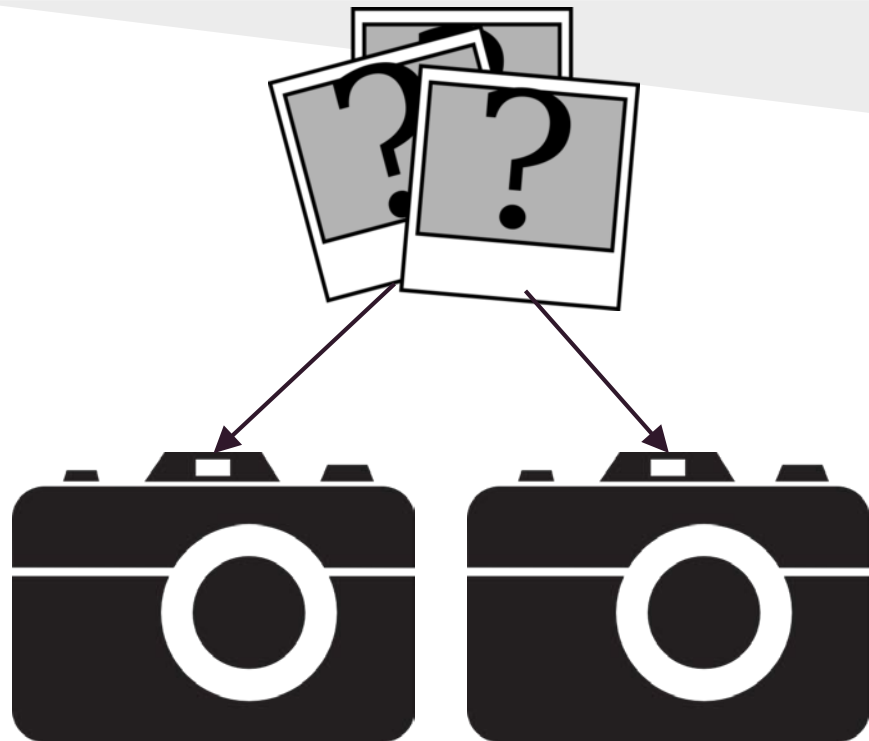


D200 Extracted K



Classifying Images

Dim	Training		Testing	
	Accuracy	Precision	Accuracy	Precision
300x300	.9933	.9933	1	1
150x150	.9664	.9664	1	1
75x75	.8758	.9128	.7632	.9474
50x50	.7953	.8322	.7105	.8421
25x25	.7282	.7651	.6579	.6842
10x10	.5503	.5638	.5789	.6316
5x5	.2933	.5168	.3421	.4211



Tampered Regions

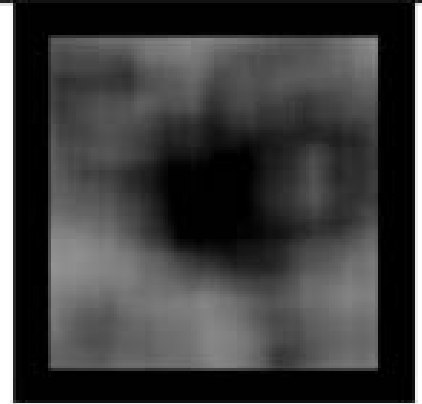
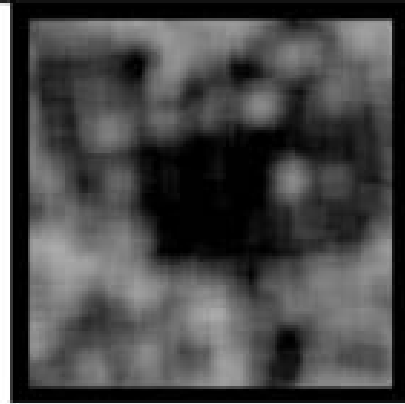
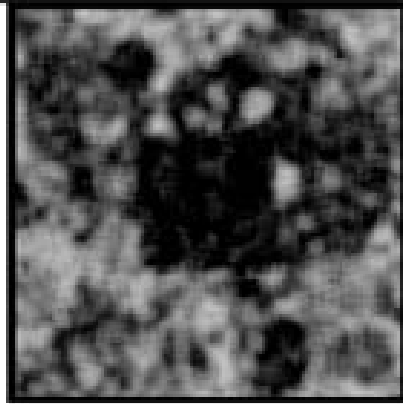
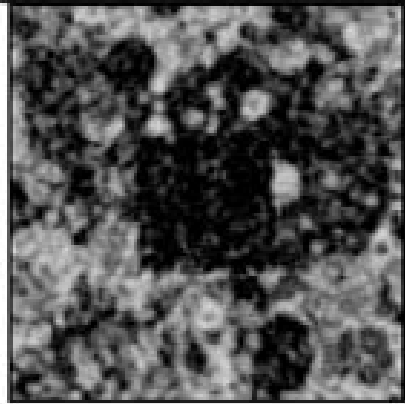
The first test was using patch correlation. The middle of the image was from a different camera.

7x7

11x11

25x25

51x51



Tampered Regions

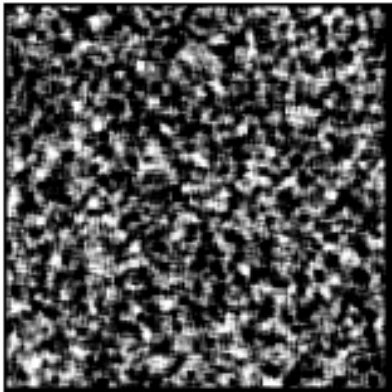
Masking the tampered and original areas, the mean and variance of each pixel region can be calculated.

	Dead leaf Image Original		Tampered Region	
Dim	Mean	Mean Variance	Mean	Mean Variance
<i>7x7</i>	.4063	.0390	.2906	.0685
<i>11x11</i>	.4108	.0268	.2895	.0567
<i>25x25</i>	.4135	.0154	.2656	.0471
<i>51x51</i>	.4085	.0103	.1006	.0099

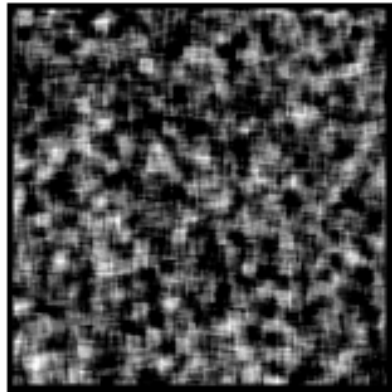
Tampered Regions

The first test was using patch correlation. The middle of the image was from a different camera.

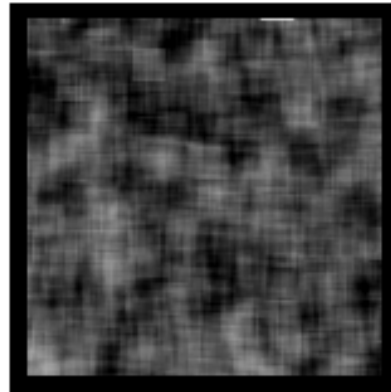
7x7



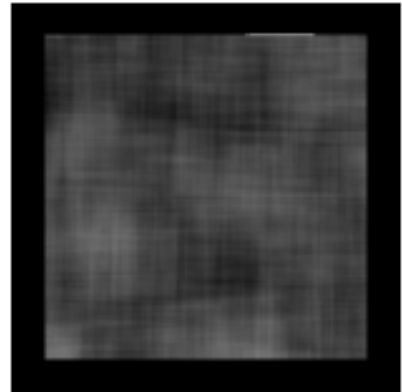
11x11



25x25



51x51



Tampered Regions

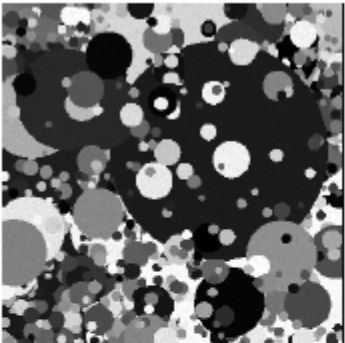
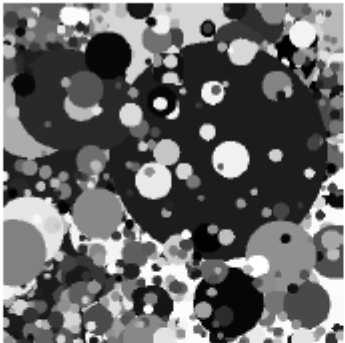
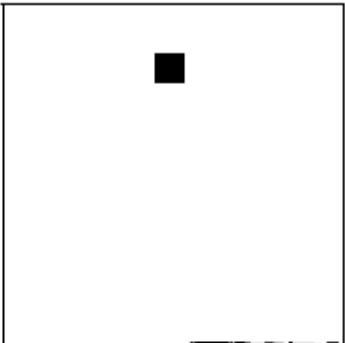
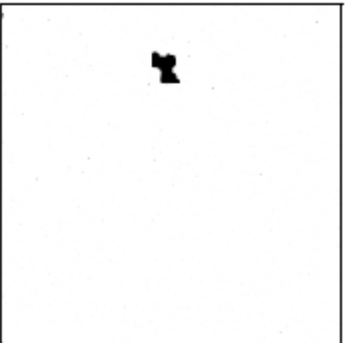
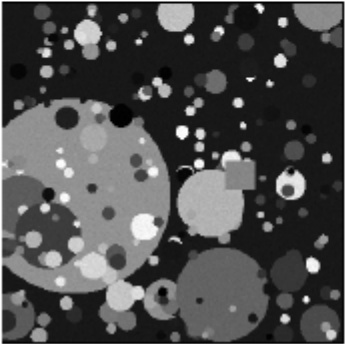
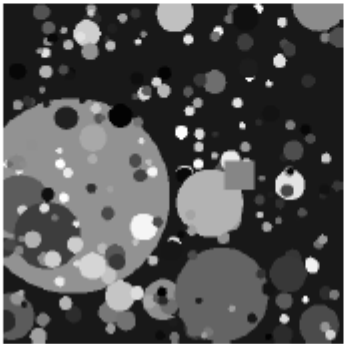
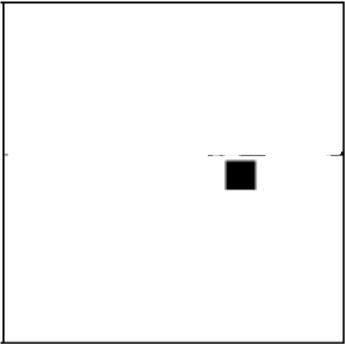
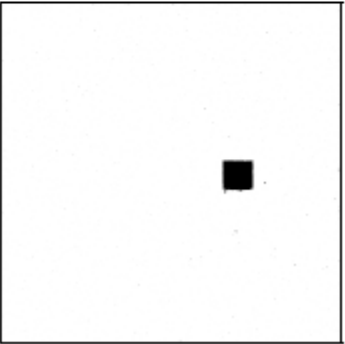
Masking the tampered and original areas, the mean and variance of each pixel region can be calculated.

Dim	D200 Image Original		Tampered Region	
	Mean	Variance	Mean	Variance
<i>7x7</i>	.0716	.0256	.0676	.0246
<i>11x11</i>	.0725	.0109	.0685	.0102
<i>25x25</i>	.0729	.0026	.0692	.0021
<i>51x51</i>	.0730	9.3678e-04	.0699	5.1987e-04

Markov Random Fields

The last tests used MRF and Loopy Belief Propagation.

Markov Random Fields

I	Y	Mask	Predicted Mask
			
			

- [1] Fridrich, J. (2009). Digital image forensics using sensor noise.
- [2] Hiraakawa, K. and Parks, T. W. (2005). Adaptive homogeneity-directed demosaicing algorithm.
- [3] Luk, J., Fridrich, J., and Goljan, M. (2005). Determining digital image origin using sensor imperfections. Technical report, Binghamton University.
- [4] Paris, S. and Durand, F. (2006). A fast approximation of the bilateral filter.
- [5] Tomasi, C. and Manduchi, R. (1998). Bilateral filtering for gray and color images. In Sixth International Conference on IEEE.

References

Thanks to my mentor Katie Bouman and advisor Bill Freeman.