Assignment 2 - Image Denoising
Report

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0. The approach used by us for this RGB image is simply an extension of the approach for a grayscale image. The most natural noise model is assumed to be gaussian. For an RGB image, for inducing gaussian noise to a pixel (3D), noise vector would be sampled from a trivariate gaussian. **For this assignment, we assumed the covariance matrix for this trivariate distribution to be a multiple of I_{3x3}.** Due to this assumption, the noise vector can now be treated as a stand normal random vector: a vector with each component sampled from a gaussian with mean 0 and a unit-variance.

   This allows us to treat each color channel of the image as an independent image. Hence the denoising procedure is first individually carried on each color channel, and a final denoised image is formed by concatenating these channels in the same order. Results, specifically from the quadratic prior show that this approach actually gives good results. For the huber and adaptive-discontinuity prior, the code for obtaining optimal hyperparameters, one that tries to minimize J(α,), the RRMSE objective function (making it as a function of the hyperparameters), seems to be stuck at some local minimum and hence gives less desired results.

1. RRMSE between noisy and noiseless images

	Channel 1	Channel 2	Channel 3
RRMSE	0.1877	0.2306	0.1948

2. Optimal values for the parameters
   2.1. Quadratic Prior:

	Channel 1	Channel 2	Channel 3
Alpha	0.84	0.8784	0.84
RRMSE(Alpha)	0.0498	0.0711	0.0490
RRMSE(0.8Alpha)	0.0553	0.0719	0.0625
RRMSE(1.2Alpha)	$1.2\alpha > 1$	$1.2\alpha > 1$	$1.2\alpha > 1$

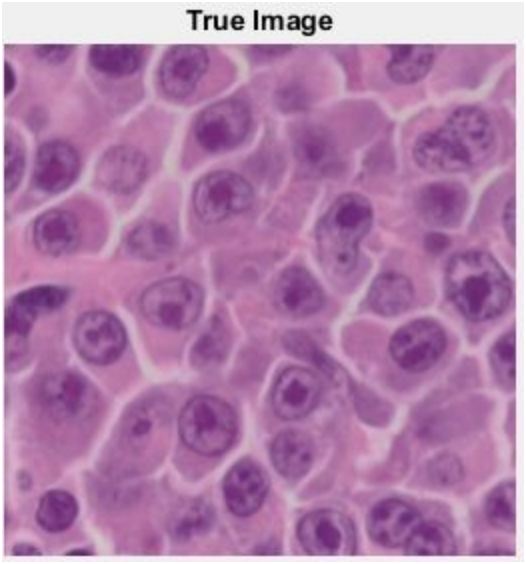
2.2. Huber Prior

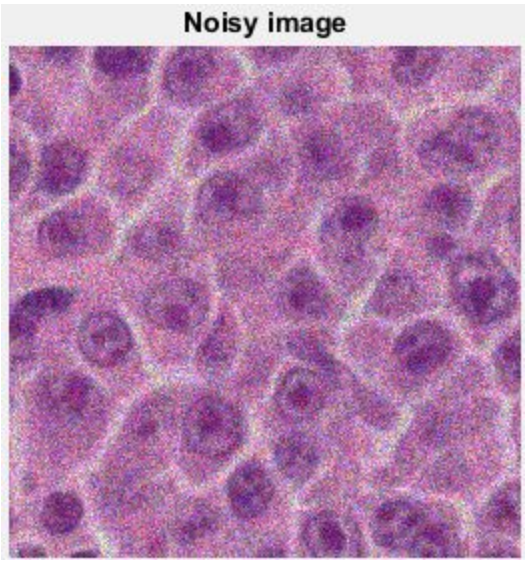
	Channel 1	Channel 2	Channel 3
Alpha	0.216	0.24	0.20
Gamma	82.94	99.5328	80
RRMSE(Alpha, Gamma)	0.1821	0.2220	0.1881
RRMSE(1.2Alpha, Gamma)	0.1826	0.2230	0.1881
RRMSE(0.8Alpha, Gamma)	0.1822	0.2220	0.1886
RRMSE(Alpha, 1.2Gamma)	0.1821	0.2220	0.1880
RRMSE(Alpha, 0.8Gamma)	0.1821	0.2220	0.1883

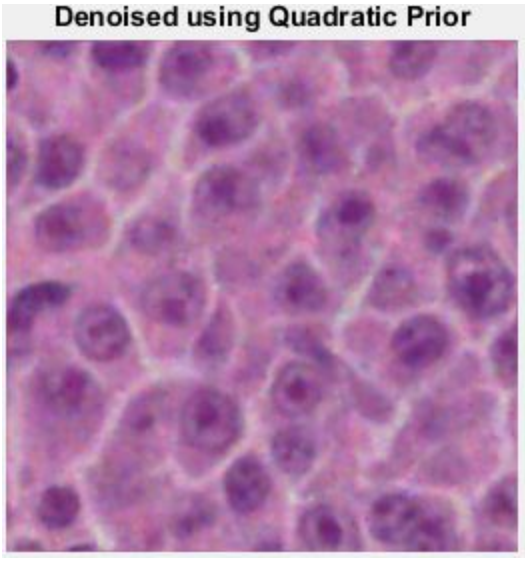
2.3. Prior 3:

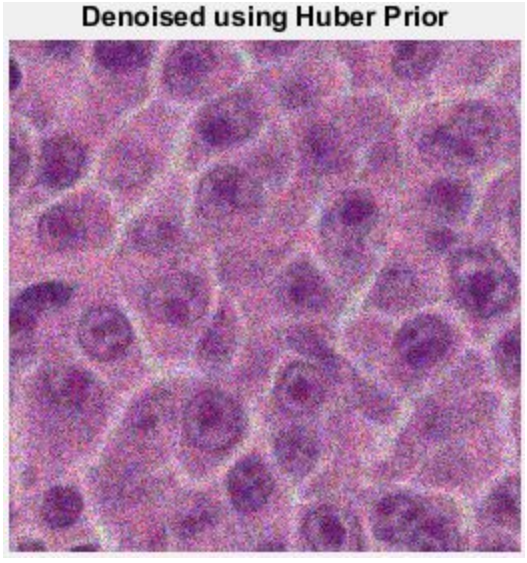
	Channel 1	Channel 2	Channel 3
Alpha	0.5	0.5	0.5
Gamma	20	20	24
RRMSE(Alpha, Gamma)	0.1824	0.2228	0.1886
RRMSE(1.2Alpha, Gamma)	0.1842	0.2256	0.1912
RRMSE(0.8Alpha, Gamma)	0.1827	0.2231	0.1887
RRMSE(Alpha, 1.2Gamma)	0.1825	0.2230	0.1889
RRMSE(Alpha, 0.8Gamma)	0.1825	0.2229	0.1886

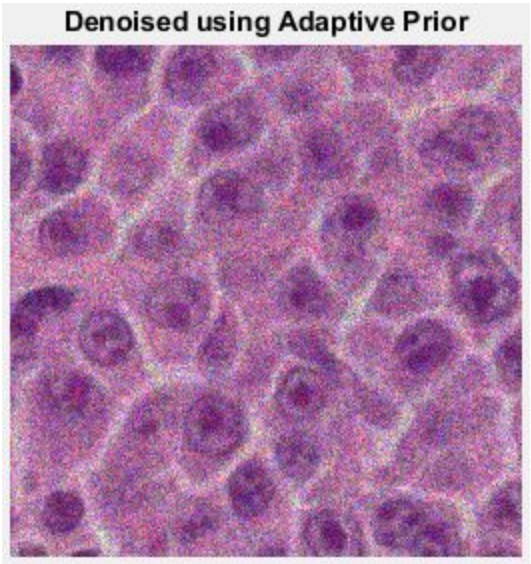
3.


True Image


Noisy image


Denoised using Quadratic Prior


Denoised using Huber Prior


Denoised using Adaptive Prior

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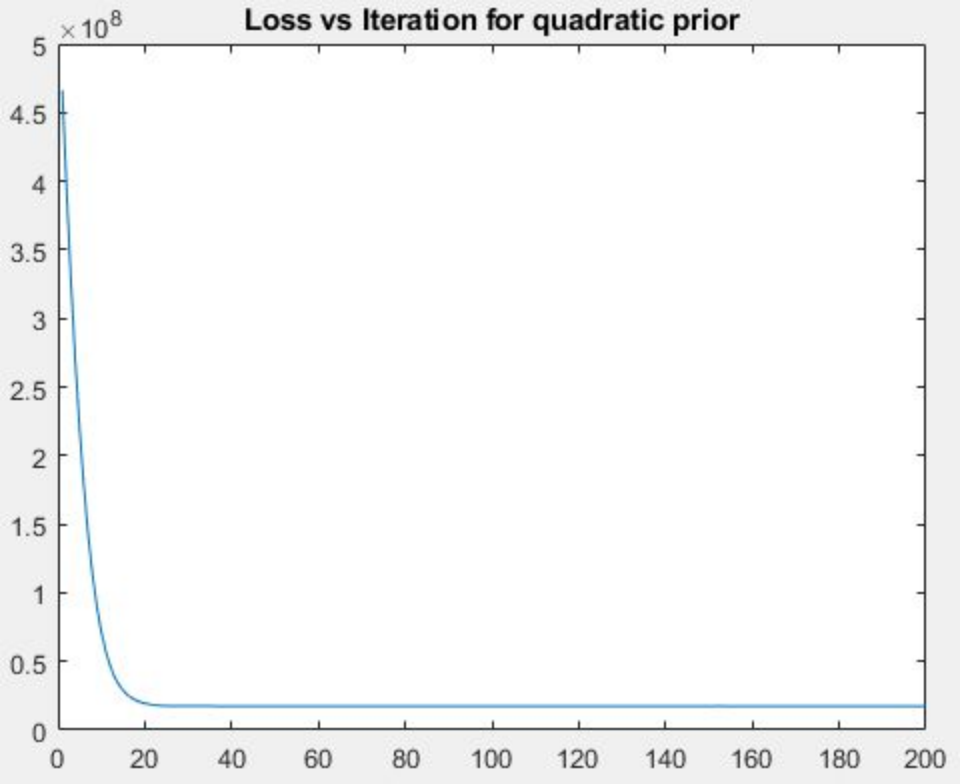
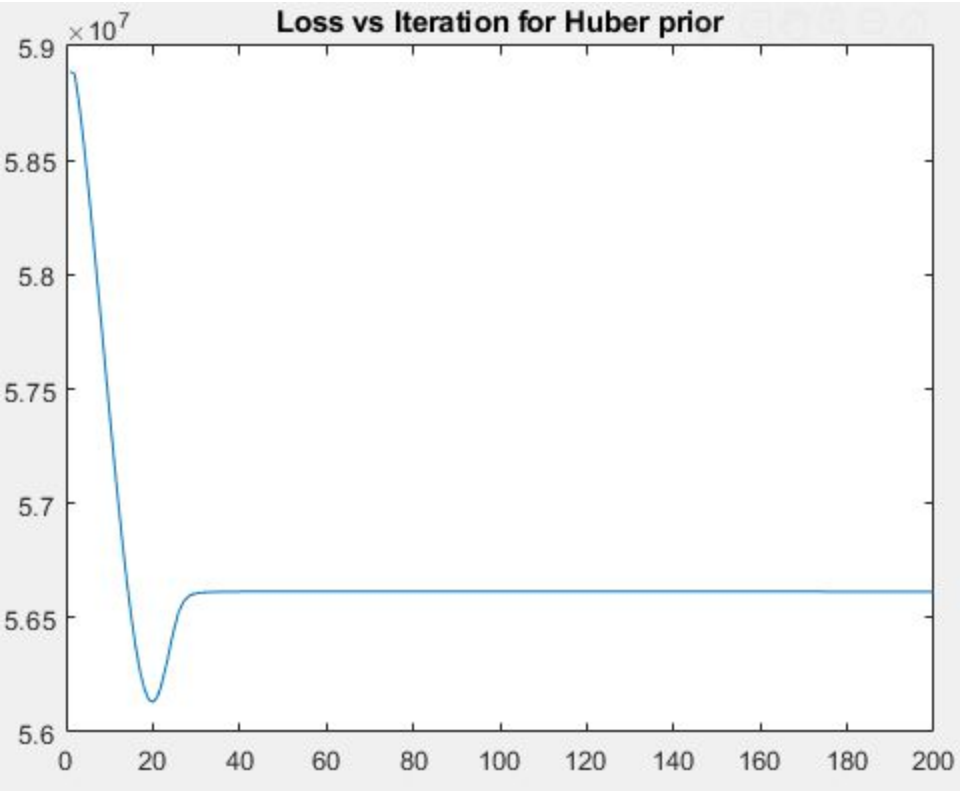
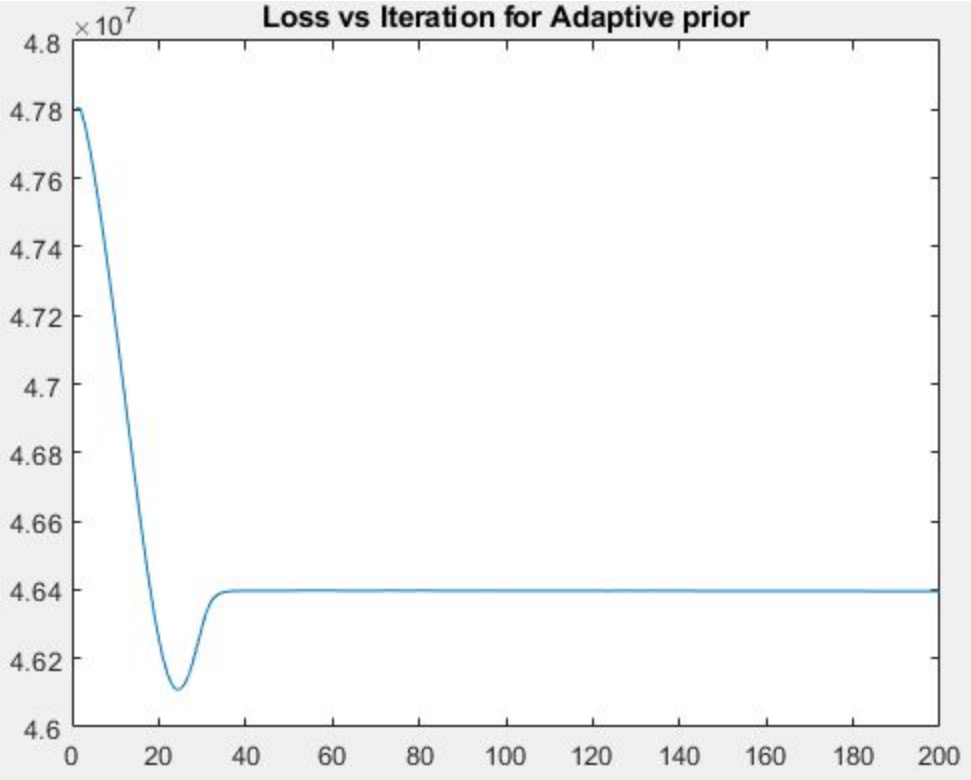

Loss vs Iteration for quadratic prior
×10^8
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
160
180
200


Loss vs Iteration for Huber prior
×10^7
5.9
5.85
5.8
5.75
5.7
5.65
5.6
0
20
40
60
80
100
120
140
160
180
200


Loss vs Iteration for Adaptive prior
×10^7
4.8
4.78
4.76
4.74
4.72
4.7
4.68
4.66
4.64
4.62
4.6
0
20
40
60
80
100
120
140
160
180
200