CS 736: Medical Image Computing

Assignment 1

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§1. Question 1

(a) The RRMSE value between the noisy and noiseless images is 0.2986

(b) Different parameter and RRMSE values for the applied priors are:

(1) MRF Prior: Quadratic Model-

i. α=0.29

ii. RRMSE(α)=0.26669

iii. RRMSE(1.2α)=0.26911

iv. RRMSE(0.8α)=0.28746

(2) MRF Prior: Discontinuity-adaptive Huber function-

i. α=0.01

ii. γ=0.68

iii. RRMSE(α, γ)=0.27816

iv. RRMSE(1.2α, γ)=0.27788

v. RRMSE(0.8α, γ)=0.27843

vi. RRMSE(α, 1.2γ)=0.27829

vii. RRMSE(α, 0.8γ)=0.27820

(3) MRF Prior: Discontinuity-adaptive function-

i. α=0.01

ii. γ=0.01

iii. RRMSE(α, γ)=0.27947

iv. RRMSE(1.2α, γ)=0.27945

v. RRMSE(0.8α, γ)=0.27948

vi. RRMSE(α, 1.2γ)=0.27948

vii. RRMSE(α, 0.8γ)=0.27945

(c) Images expressed as color jetmap:

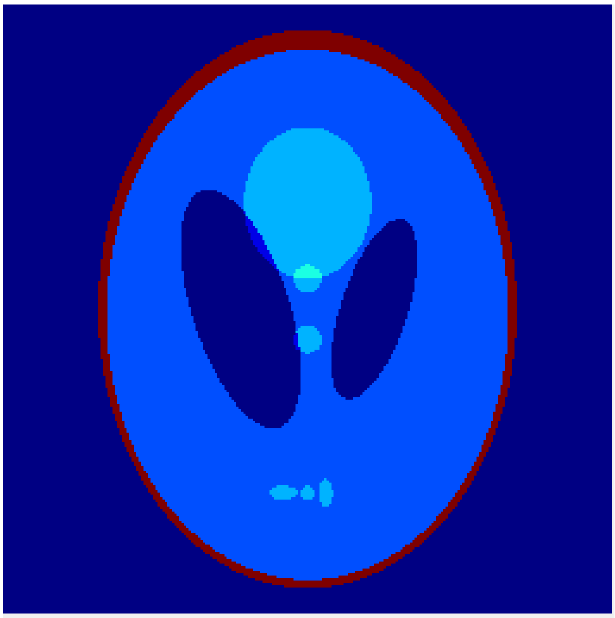

Figure 1: Noiseless Image (Phantom)

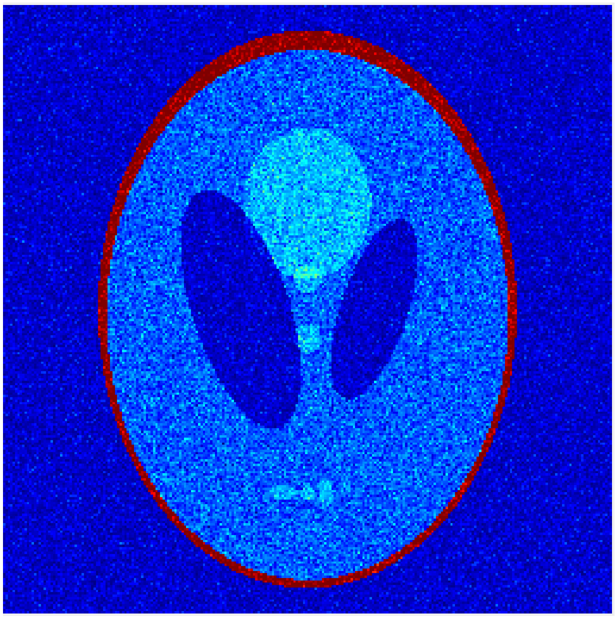

Figure 2: Noisy Image (Phantom)

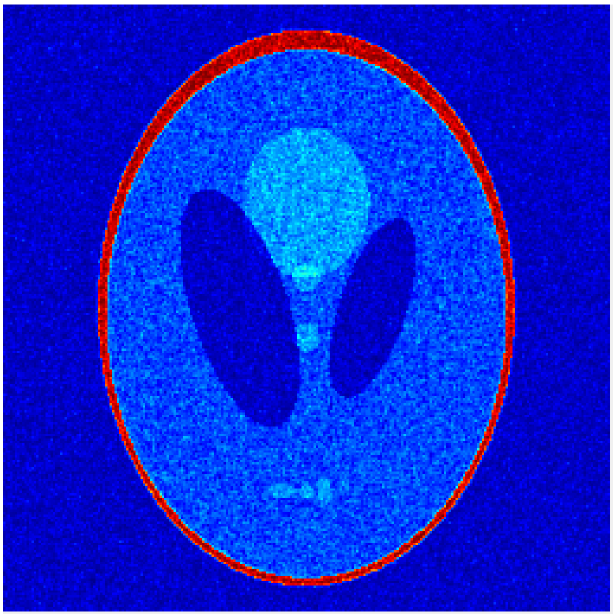

Figure 3: MRF Prior: Quadratic (Phantom)

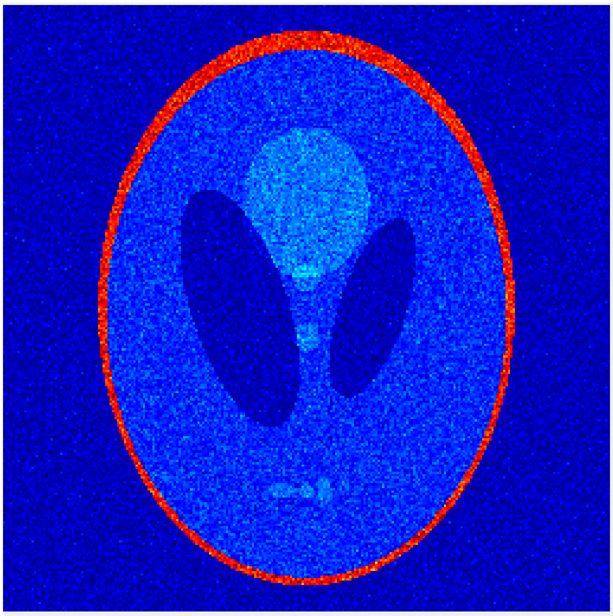

Figure 4: MRF Prior: Discontinuity-adaptive Huber (Phantom)

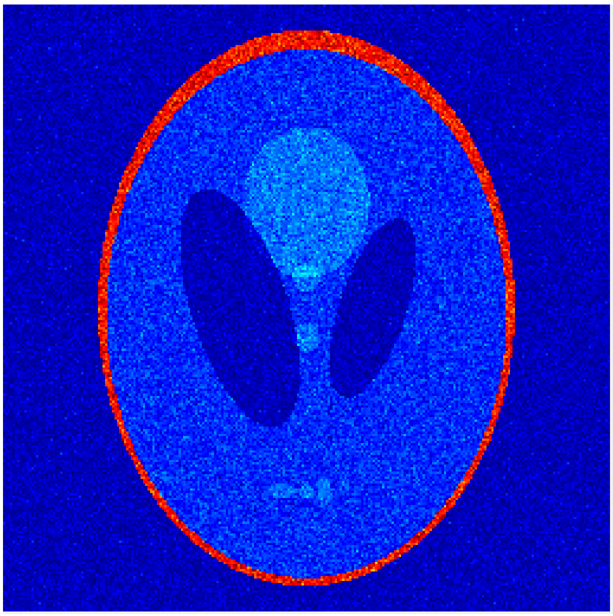

Figure 5: MRF Prior: Discontinuity-adaptive (Phantom)

(d) Plots of RRMSE vs iteration:

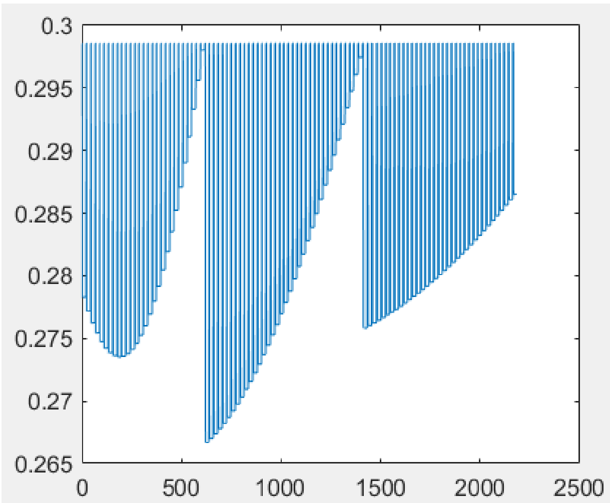

Figure 6: MRF Prior: Quadratic (Phantom)

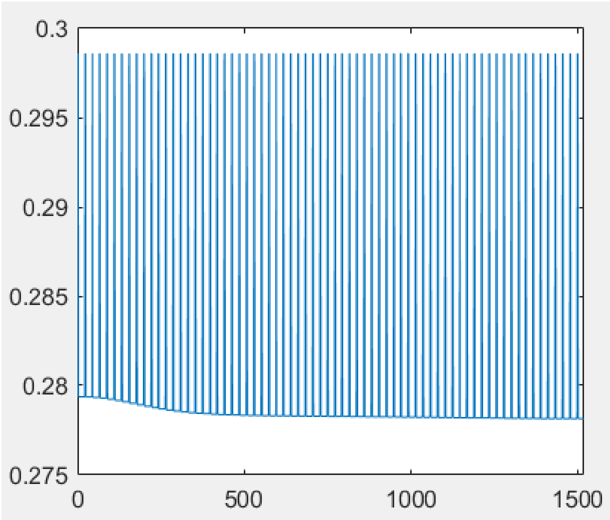

Figure 7: MRF Prior: Discontinuity-adaptive Huber (Phantom)

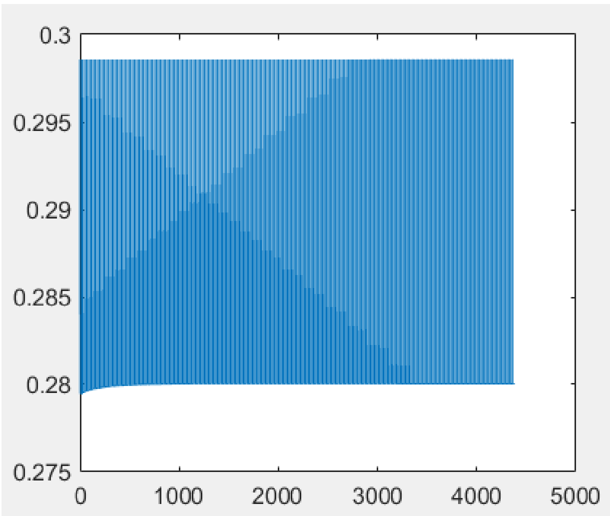

Figure 8: MRF Prior: Discontinuity-adaptive (Phantom)

§2. Question 2

(a) The RRMSE value between the noisy and noiseless images is 0.14245

(b) Different parameter and RRMSE values for the applied priors are:

(1) MRF Prior: Quadratic Model-

i. α=0.82
ii. RRMSE(α)=0.11925
iii. RRMSE(1.2α)=0.12070
iv. RRMSE(0.8α)=0.13245

(2) MRF Prior: Discontinuity-adaptive Huber function-

i. α=0.01
ii. γ=0.69
iii. RRMSE(α, γ)=0.14092
iv. RRMSE(1.2α, γ)=0.14086
v. RRMSE(0.8α, γ)=0.14097
vi. RRMSE(α, 1.2γ)=0.14092
vii. RRMSE(α, 0.8γ)=0.14092

(3) MRF Prior: Discontinuity-adaptive function-

i. α=0.01
ii. γ=0.01
iii. RRMSE(α, γ)=0.14116
iv. RRMSE(1.2α, γ)=0.14115*
v. RRMSE(0.8α, γ)=0.14117
vi. RRMSE(α, 1.2γ)=0.14116
vii. RRMSE(α, 0.8γ)=0.14115*

* - Lesser RRMSE becausewell below the precision of our gamma steps

(c) Images expressed as color jetmap:

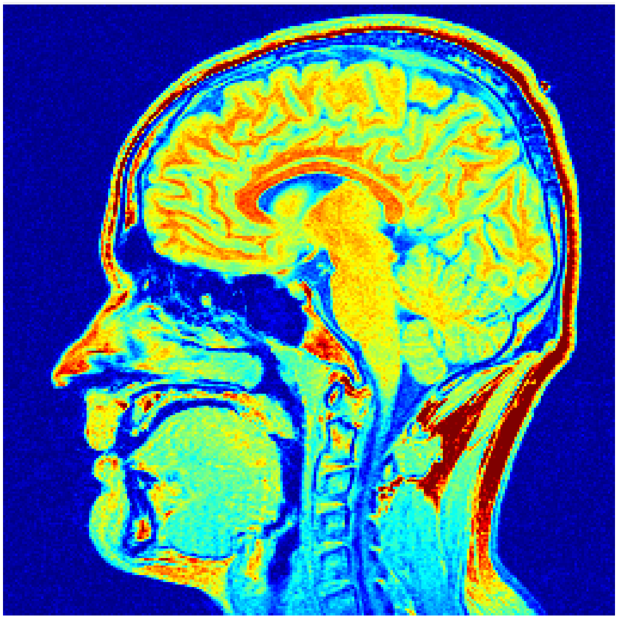

Figure 9: Noiseless Image (Brain MRI)

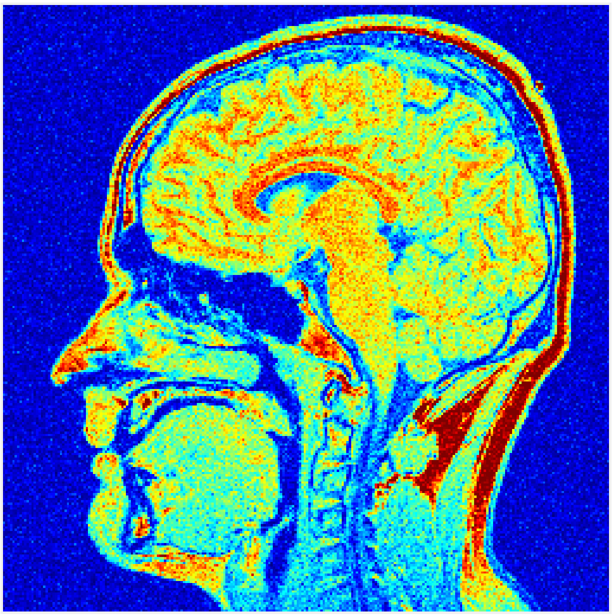

Figure 10: Noisy Image (Brain MRI)

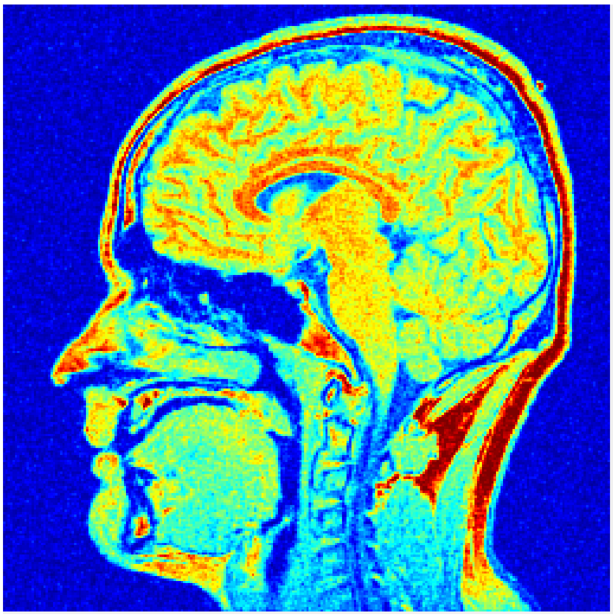

Figure 11: MRF Prior: Quadratic (Brain MRI)

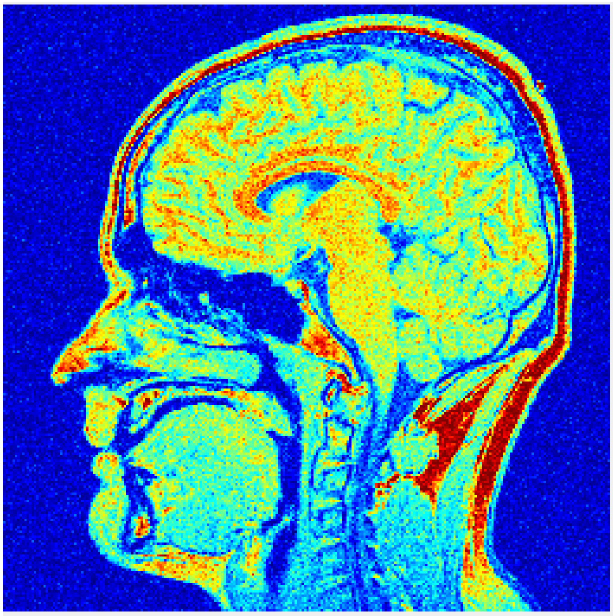

Figure 12: MRF Prior: Discontinuity-adaptive Huber (Brain MRI)

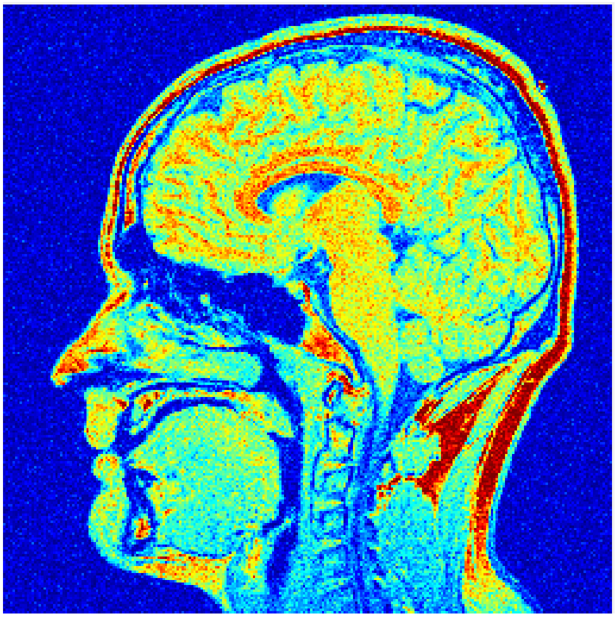

Figure 13: MRF Prior: Discontinuity-adaptive (Brain MRI)

(d) Plots of RRMSE vs iteration:

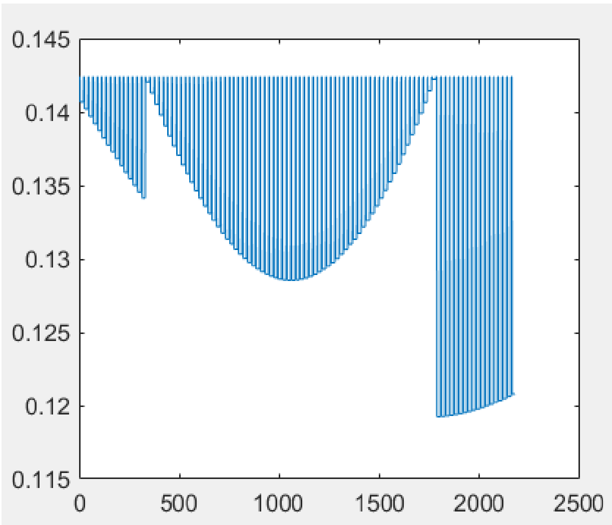

Figure 14: MRF Prior: Quadratic (Brain MRI)

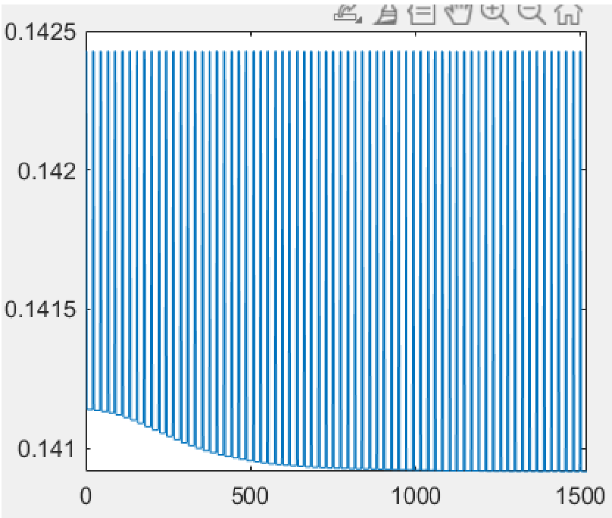

Figure 15: MRF Prior: Discontinuity-adaptive Huber (Brain MRI)

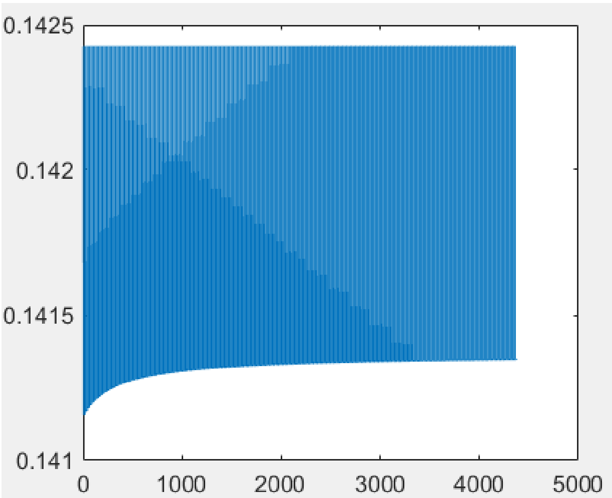

Figure 16: MRF Prior: Discontinuity-adaptive (Brain MRI)

§3. Question 3

(a) A suitable MRF Prior for the coloured image with statistical dependency on RGB channels could be the Disconitnuity Adaptive Huber function coupled with a 6 neighbour neighbourhood system. We need a six neighbour system because the different colour channels are said to be statistically dependent on each other.
Also, RGB microscopy images have many discontinuities and outliers which is why a quadratic prior function wouldn't be ideal.
The updates to this will be performed in the same way using circshift but with additional shifts in the third dimension to account for added neighbors via coloured channels.

(b) A suitable noise model is the poisson model as mentioned in the slides. Lambda shall be the true signal value and we will update using the corresponding cost function.

(c) Using gradient descent updates we can do the same algorithm as black and white image. It shall be more computationally expensive.