PGM Assignment 3:

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Task 1:

Values:

T1 = toy_stripes(n, m, sSize),

n = 250, m = 250, sSize = 250

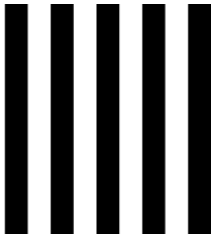

Fig 1: Stripes original

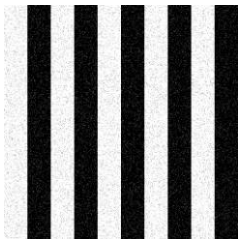

Fig 2: Added gaussian noise (0.25)

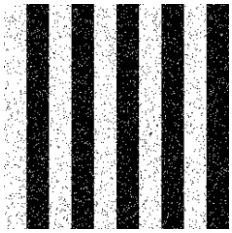

Fig 3: SnP noise (0.1)

T2 = toy_checkerboard(n, (n, m, cSize),

n = 250, m = 250, cSize = 250

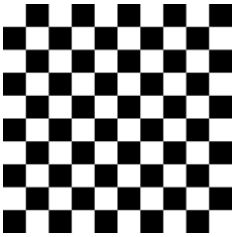

Fig 4: Checkboard original

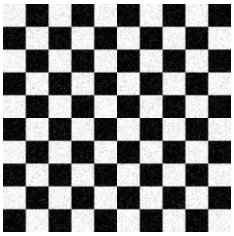

Fig 5: Added gaussian noise (0.25)

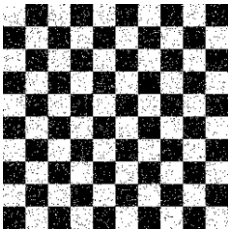

Fig 6: SnP noise (0.1)

PSNR of stripes orignal image (T1) with SnP noise of 0.1 = 25.436753177896424

PSNR of checkboard orignal image (T2) with SnP noise of 0.1 = 25.377792584532692

Median Filtering:

10% salt and pepper noise.

Window size =7

Gaussian noise of sigma 25 added to la.png which is then denoised with median filtering.

Fig: Image with Gaussian noise.

PSNR: 36.375417654653965

Fig: Denoised image.

PSNR: 32.239577033535940

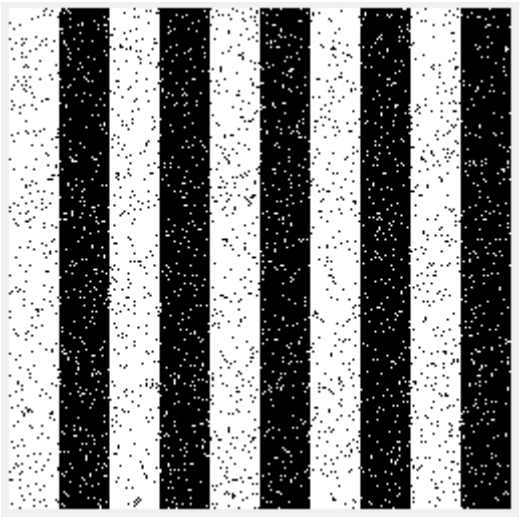

Fig: Stripes image with SnP noise.

PSNR: 25.541041616837560

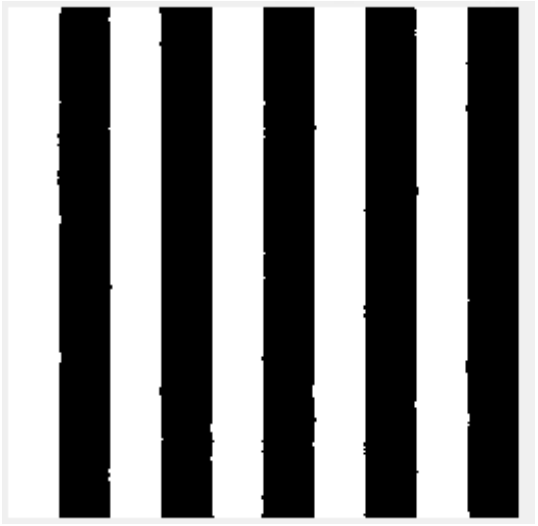

Fig: Denoised stripe image.

PSNR: 35.900208426989536

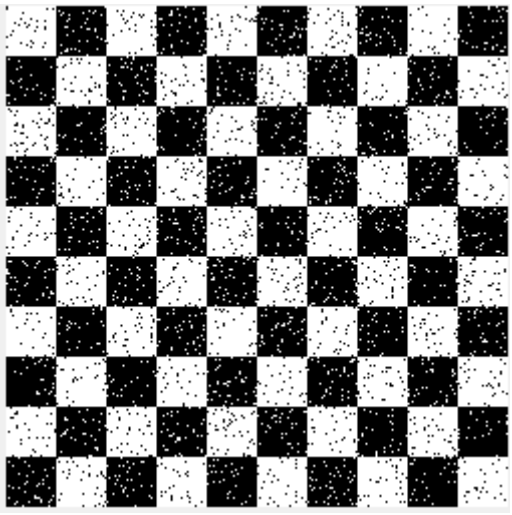

Fig: Checkboard Image with SnP noise.

PSNR: 25.368113415175200

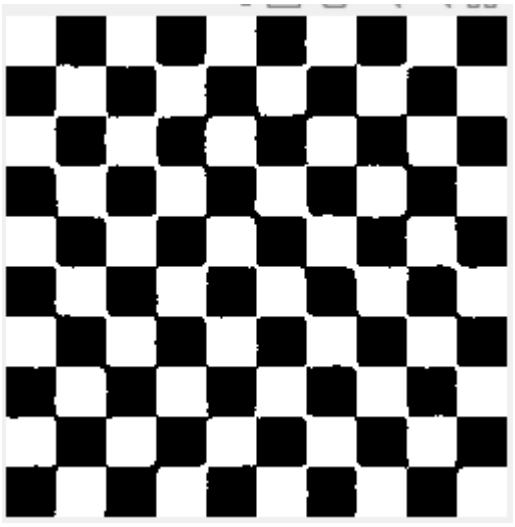

Fig: Denoised image.

PSNR: 27.991134186955190

Median filter denoising worked best in artificial images(PSNR increased) but not in the original la.png image(psnr decreased).

Trying with different values of sigma:

Sigma	Gaussian Noise	Denoised image
0.25	36.375417654653965	32.239577033535940
0.50	31.268952857648358	29.838430088643790
0.75	27.912589838875483	27.925827502710190
1	24.682559264409660	27.117945997522100

So we see that for high values of sigma, we get better values for denoised images, hence median filtering denoising works better for the higher values of sigma for the image la.png.

3 MRF-based Denoising with Gradient Ascent

Comparing MRF and Median filtering.

Fig: Stipes image after applying MRF.

PSNR with noisy image: 25.541041616837560

PSNR after denoising(median filtering): : 35.900208426989536

PSNR after MRF: 19.955423392231424

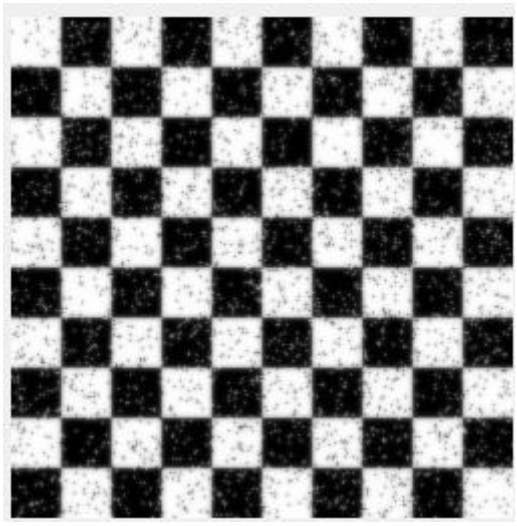

Fig: Checkboard image after applying MRF.

PSNR with noisy image: 25.368113415175200

PSNR after denoising(median filtering): : 27.991134186955190

PSNR after MRF: 17.842285807881060

Fig: la.png after applying MRF.

PSNR with noisy image: 36.686515220467680

PSNR after denoising(median filtering): : 31.954701887550776

PSNR after MRF: 29.922846364145280

4. Student prior:

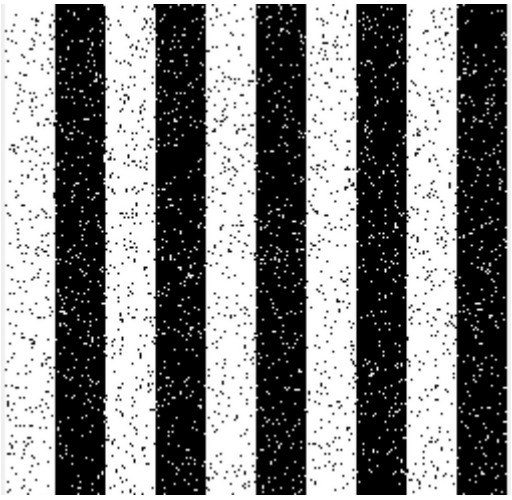

Fig: Stripes image after applying MRF using student prior.

PSNR MRF student prior: 25.394172603812372

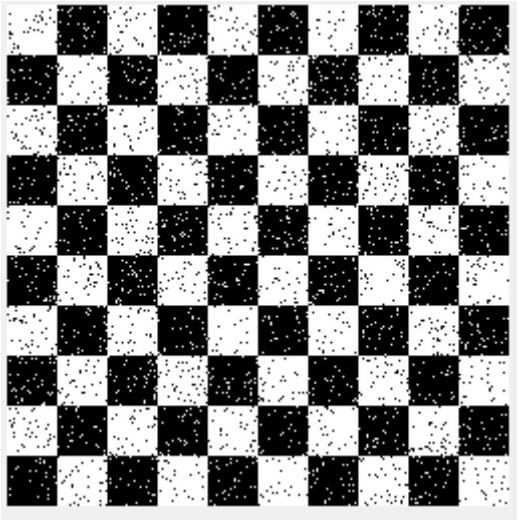

Fig: Checkboard image after applying MRF using student prior.

PSNR MRF student prior: 25.160997626359638

Fig: la.png after applying MRF using student prior.

PSNR MRF student prior: 29.922846364145280

5 Independence Assumption

Most of the noise is dependent, but we can have an independence assumption as it simplifies the problem and there is not significant difference.

If we add spatially dependent noise to the image, for our case we add gaussian noise as strips in the original image, to make it dependent.

6 Bonus (Color images).

As color images have 3 channels, we can use some type of image representations which has all the major image components and high intensity objects in one channel, for Eg in YCbCr channel.

Here all the high intensity objects are in Y channel which can be used for denoising and then we can transfer it back to the RGB image.