

Computational Photography

Assignment 2 Report

106061704

Yun-Sheng Chang

PSNR Results

Image	Algorithm	PSNR (Linux)	PSNR (Windows)
curiosity_small	RL	55.67	inf
curiosity_small	BRL	57.56	inf
cv_book	RL	51.29	inf
cv_book	BRL	51.29	inf

Outline

- RL and BRL
- BRL with different parameters
- RL/BRL on self-taken blurred images
- TVL1 with different λ and different solver
- TVL1, TVL2 and TV Poisson

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Curiosity Small

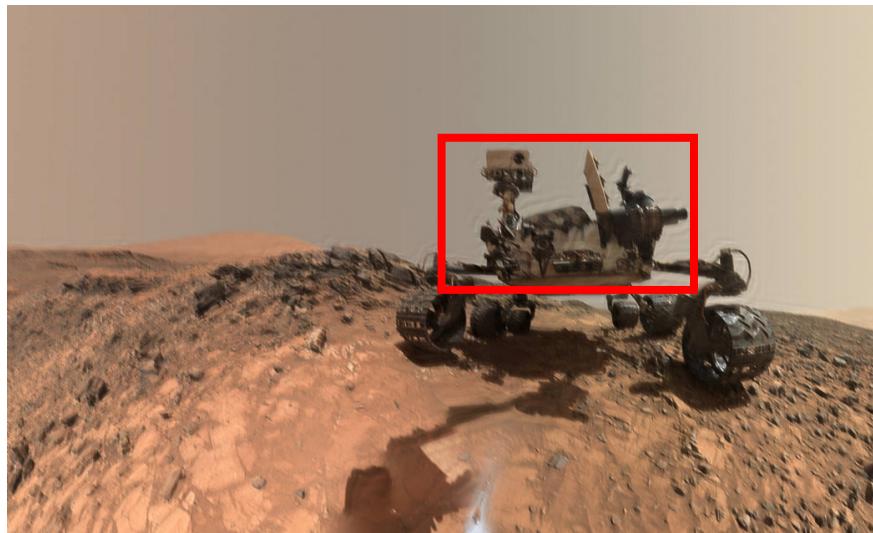


RL

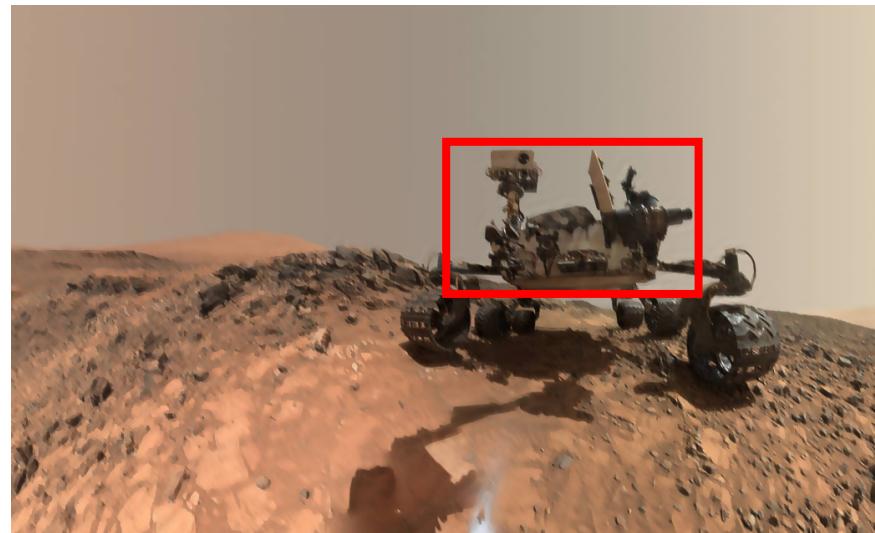


BRL

Curiosity Small



RL



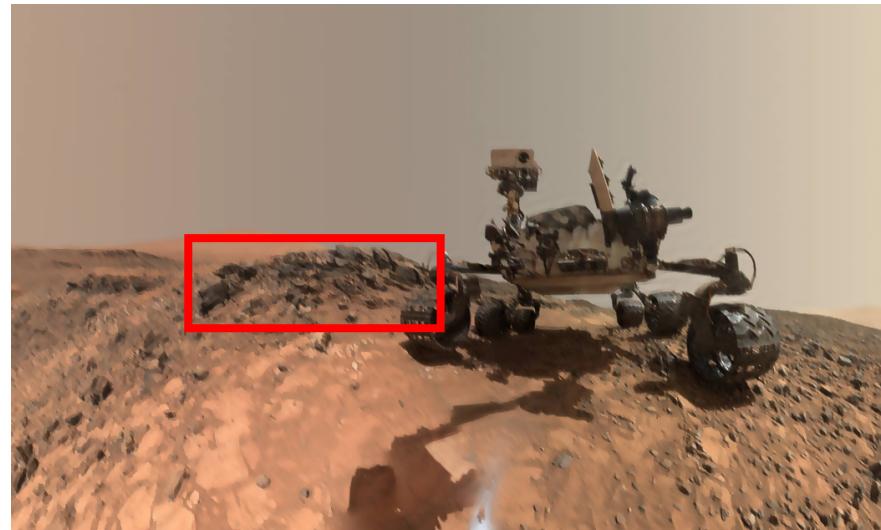
BRL



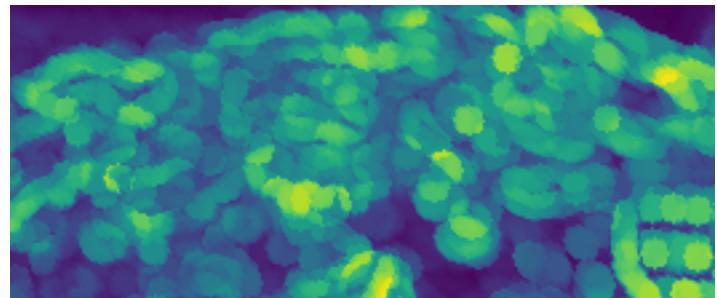
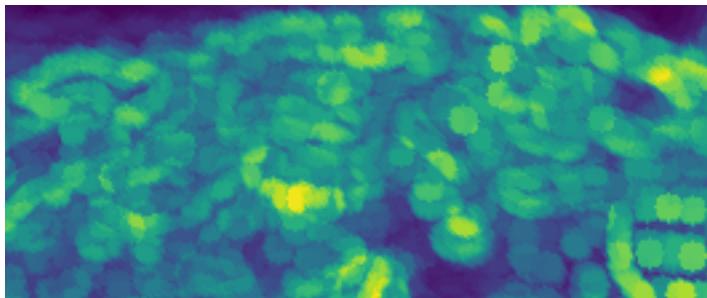
Curiosity Small



RL



BRL



low sharpness

Curiosity Medium

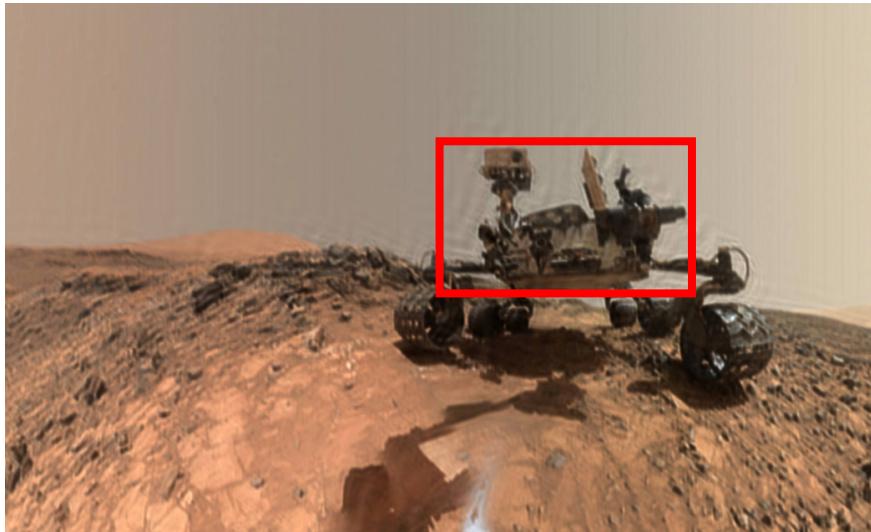


RL

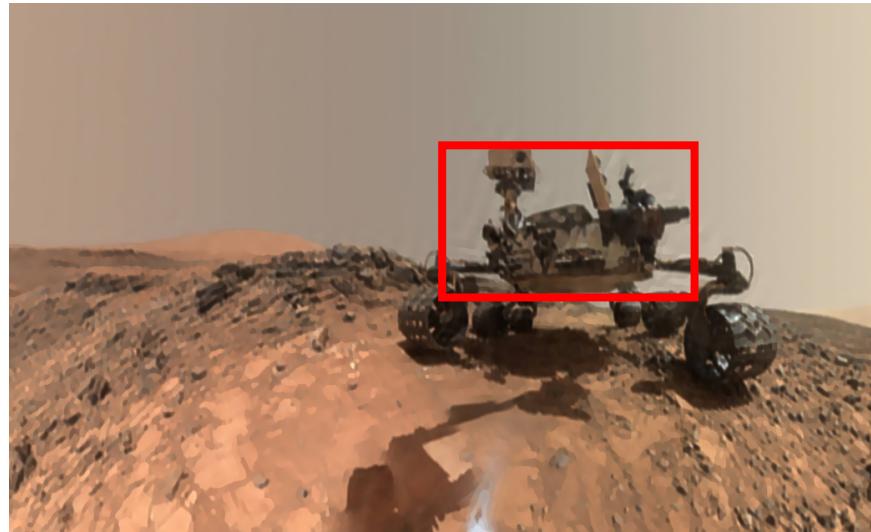


BRL

Curiosity Medium

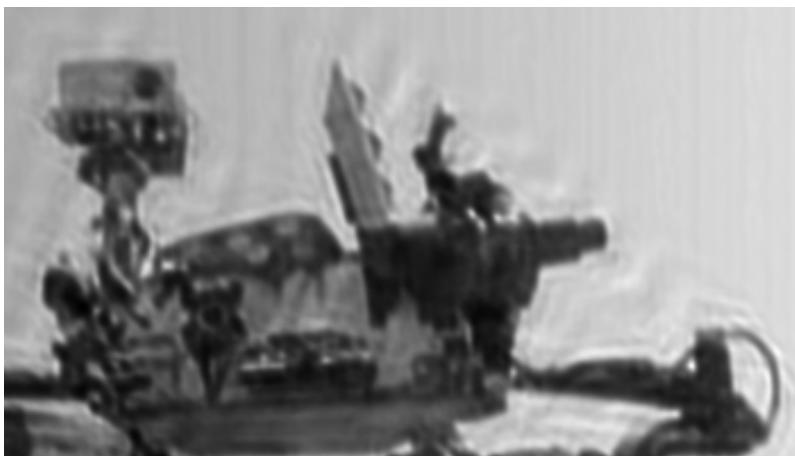


RL



BRL

both having ringing artifact



Summary

- The result of RL deconvolution has obvious ringing artifact
- The result of BRL deconvolution has lower sharpness
- When the blur kernel is too large, BRL deconvolution may also bring ringing artifact

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Different BRL Parameters

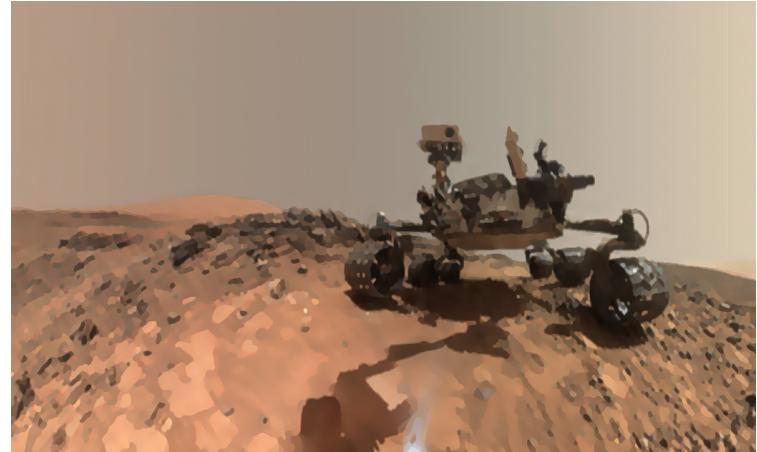
- I vary the following parameters **one at a time**
 - λ (fixed at 0.001 / 255 if not varied)
 - σ_r (fixed at 20 / 255 * 255 if not varied)
 - # of iterations (fixed at 50 if not varied)
 - boundary condition (fixed at symmetric if not varied)
 - r_Ω to r_k ratio (fixed at 0.5 if not varied)
- In order to perform the experiment efficiently, I parallelize the RBL deconvolution process
 - each run (with 50 iterations) takes about 800 seconds
 - however, the parallel version can only run on Linux but not on Windows; thus, the code I submitted is the single-threaded version

Different λ

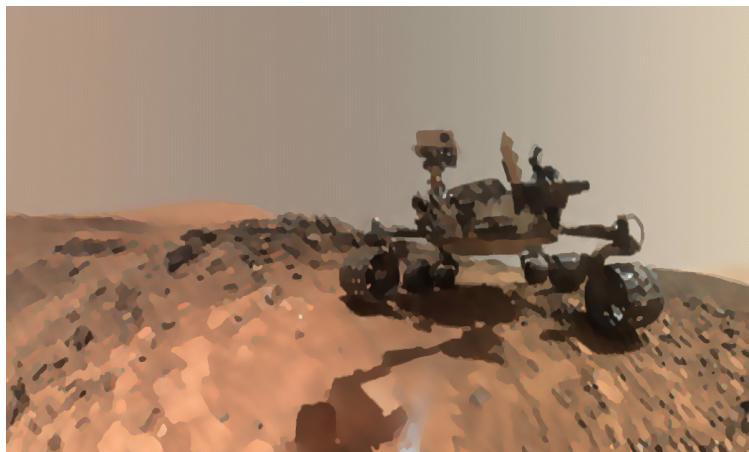
sharp



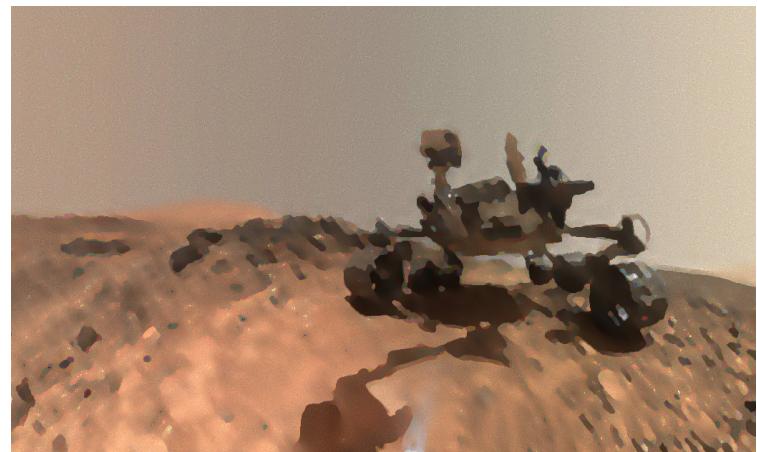
$\lambda = 0.001$



$\lambda = 0.005$



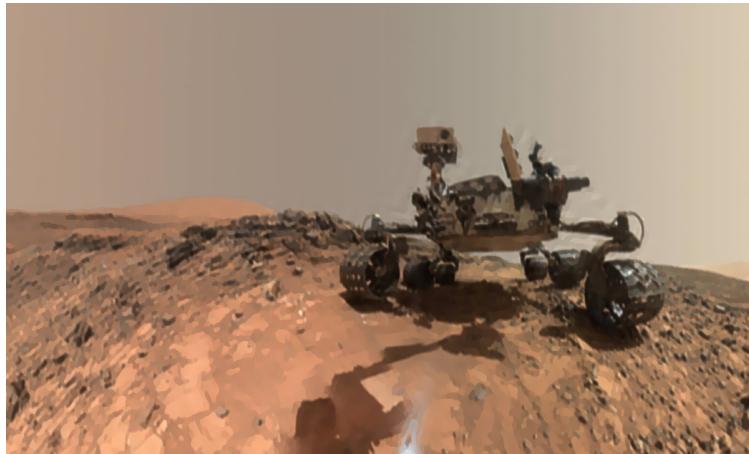
$\lambda = 0.01$



$\lambda = 0.05$

very smooth

Different σ_r



$\sigma_r = 10$



$\sigma_r = 20$



$\sigma_r = 40$



$\sigma_r = 80$

ringing artifact increase a little bit

Different # of Iterations



of iterations = 10



of iterations = 30



of iterations = 50



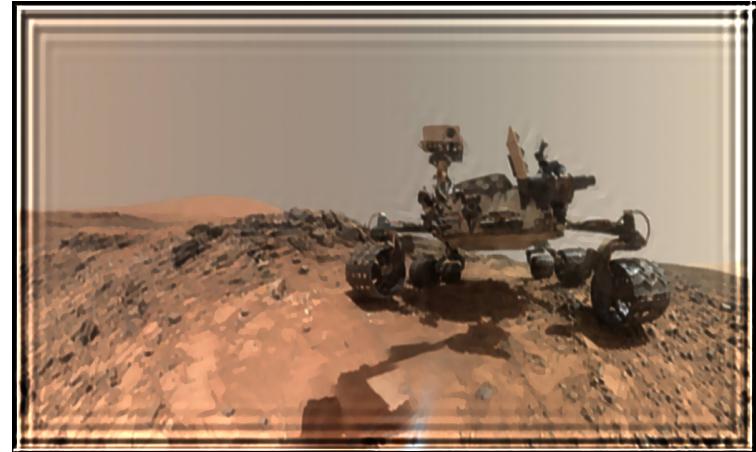
of iterations = 90

Different Boundary Conditions

bad boundary results



wrap



fill 0



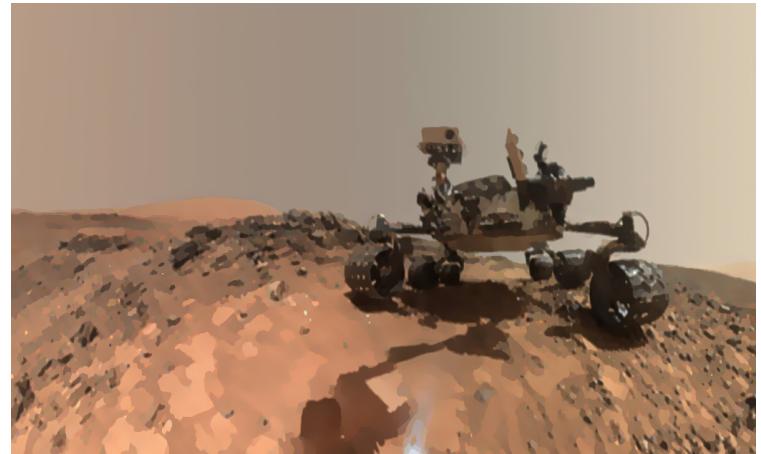
symmetric

Different r_Ω to r_k ratios

ringing artifact



many details are not preserved



$r_\Omega = 0.33 r_k$



$r_\Omega = r_k$

$r_\Omega = 0.5 r_k$

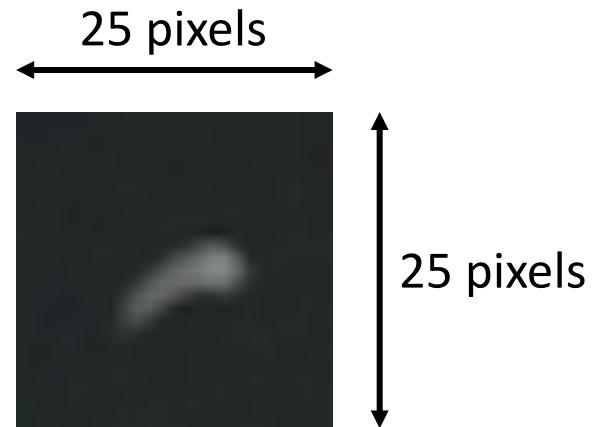
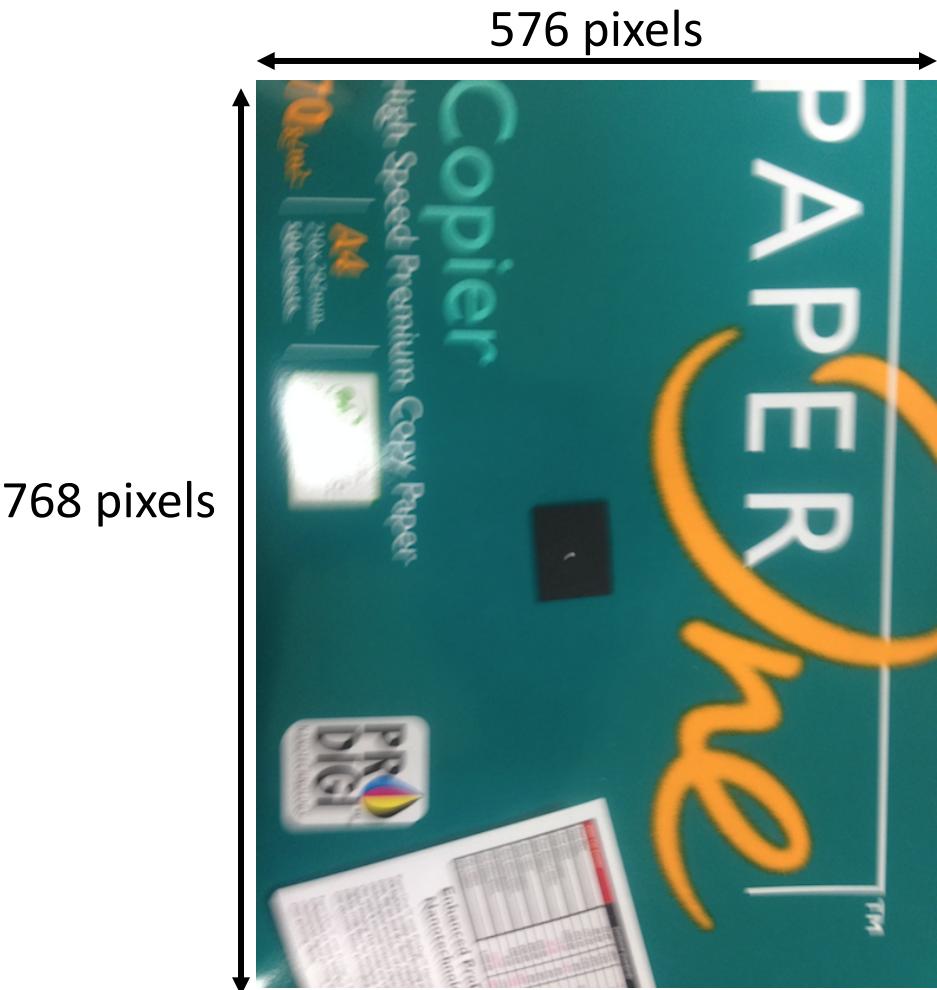
Summary

- Increasing λ makes the result smoother
- Increasing σ_r seems to increase the ringing artifact, though the effect is very limited
- Increasing the number of iterations yields a result with better deblur performance and less ringing artifact
- Symmetric boundary condition seems to be the best boundary condition
- Increasing the r_Ω to r_k ratio decreases the ringing artifact, but many details are lost

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Self-Taken Image and Kernel



Preprocessing the Blur Kernel

- The black background of the original kernel has intensity around 50, causing a bad deblurred result
- Therefore, I preprocess the blur kernel such that the background has exactly the intensity 0



original blurred kernel



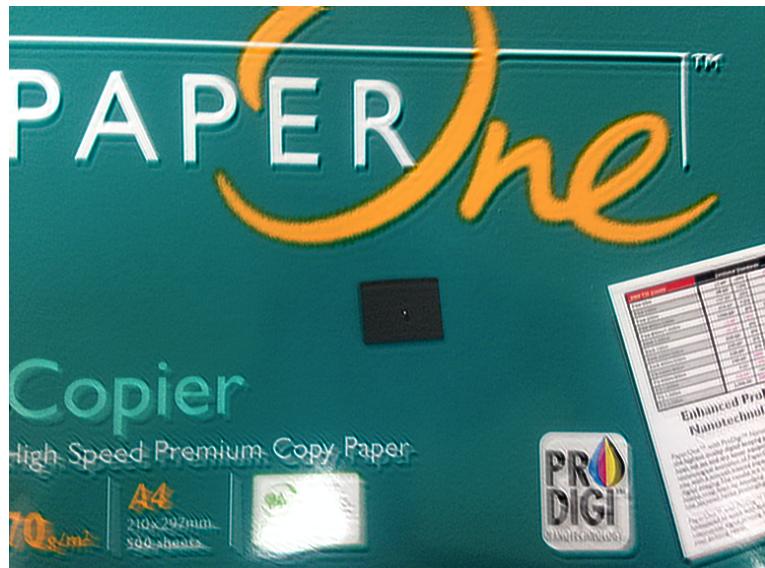
preprocessed blurred kernel

Choosing BRL Parameters

- To find a good combination of parameters, I brute-force search every combination of the following parameters
 - $\lambda = 0.001, 0.005, 0.01, 0.05, 0.1$
 - $\sigma_r = 10, 30, 50, 70, 90$
 - # of iterations = 50

$\sigma_r = 10$  $\lambda = 0.001$ $\lambda = 0.005$ $\lambda = 0.01$ $\lambda = 0.05$ $\lambda = 0.1$

Observation

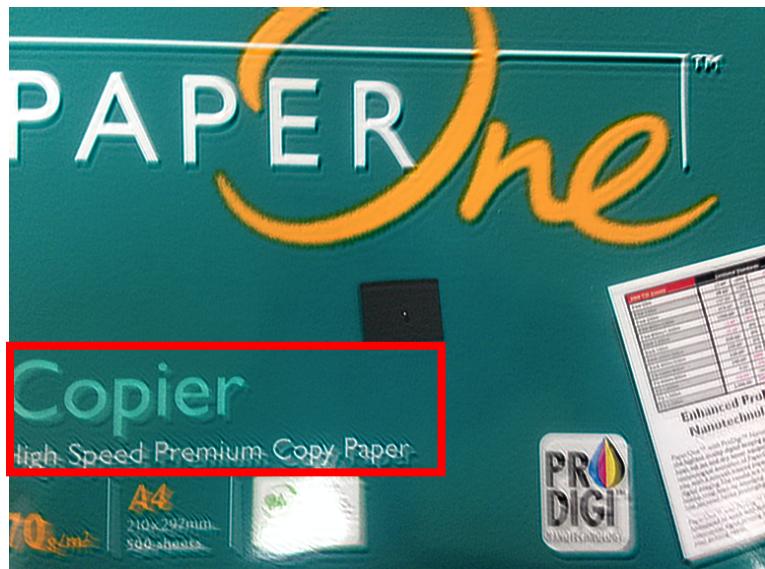


$$\lambda = 0.001, \sigma_r = 50$$

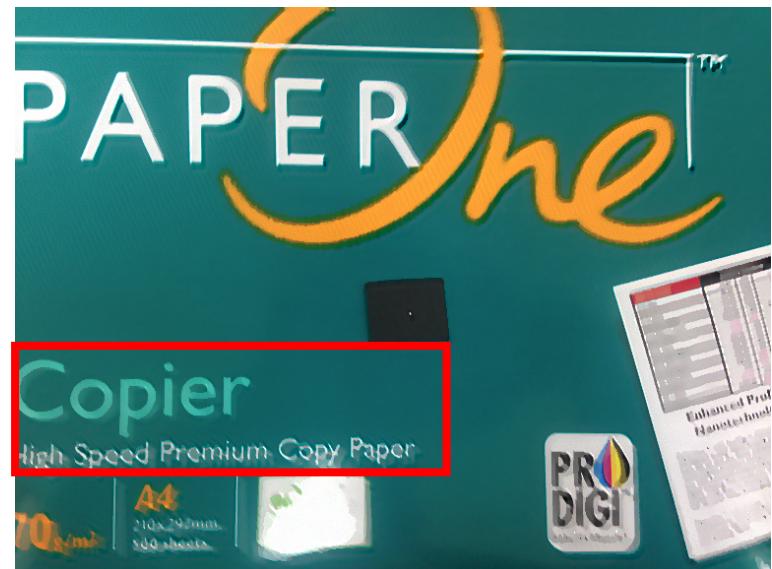


$$\lambda = 0.05, \sigma_r = 50$$

Observation



$$\lambda = 0.001, \sigma_r = 50$$

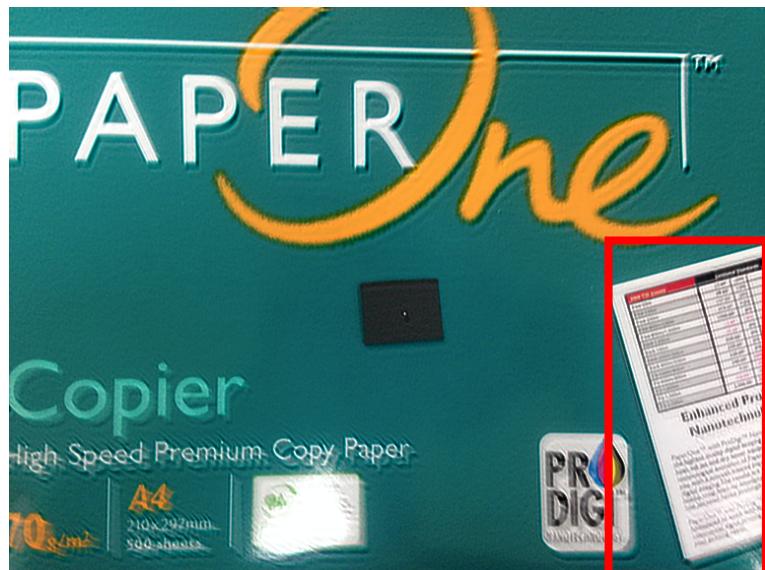


$$\lambda = 0.05, \sigma_r = 50$$



better deblurred result

Observation



$$\lambda = 0.001, \sigma_r = 50$$



$$\lambda = 0.05, \sigma_r = 50$$



better deblurred result



Summary

- Different combinations of RBL parameters may suit different forms of figure
 - E.g., words with large font size may prefer a large λ , whereas words with small font size may prefer a small λ

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TVL1 Results with PC Solver



pc, $\lambda = 0.001$



pc, $\lambda = 0.01$



pc, $\lambda = 0.1$

TVL1 Results with ADMM Solver



admm, $\lambda = 0.001$



admm, $\lambda = 0.01$



admm, $\lambda = 0.1$

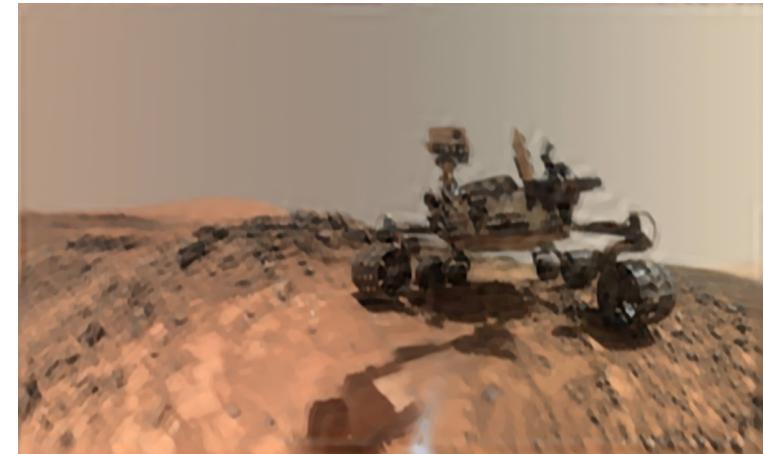
Summary

- With a small λ , the ringing artifact becomes more obvious
- With a large λ , less details are preserved because of the large regularization term

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TVL2 and TVPoisson Results



L2, pc, $\lambda = 0.01$

Poisson, pc, $\lambda = 0.01$



L1, pc, $\lambda = 0.01$

Execution Time

Data Term	Solver	λ	Exec Time (s)
L1	PC	0.001	2744
L1	PC	0.01	1389
L1	PC	0.1	1589
L1	ADMM	0.001	2063
L1	ADMM	0.01	1585
L1	ADMM	0.1	4687
L2	PC	0.01	76
Poisson	PC	0.01	339

Summary

- Comparing to L1-norm data term, L2 norm and Poisson norm seems less effective
- L1-norm data term is more time-consuming