Denoising and Demosaicing of Natural Images Using k-SVD

Course Project
CS 763: Computer Vision

Nilesh Kulkarni, 110050007
Tanmay Randhavane, 110050010
Deepali Adlakha, 11D170020

Table of Contents

Image Denoising

Algorithm

We learn the dictionary on a set of 24 natural images using KSVD. The sparse coding is done with OMP using varying values of gamma as discussed in the paper. The testing is done on the some test images, and one of these is the church image as shown in the Experiments section.

Experiments

Different types of dictionaries

We compare the performance of a k-svd trained dictionary with that of a DCT dictionary. For this experiment, we used following original image and added a Gaussian noise with standard deviation (σ) = 15.

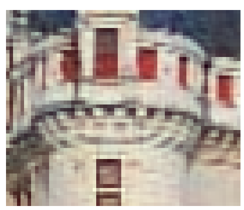
k-SVD dictionary (PSNR = 27.0499)	DCT dictionary (PSNR = 31.18)
	

The resulting images from both the algorithms are shown above. We can observe that the image obtained from DCT dictionary has blurred image details alongwith removal of noise. k-SVD dictionary avoids blurring out of the original image details.

Different sizes of dictionary

The number of atoms in the k-svd trained dictionary affects the denoising.

42 (PSNR = 25.8896)	256 (PSNR = 27.0499)
	

Original	42	256
		

The small dictionary is not able to model the colour changes that well. That can be seen wrt a larger dictionary.

Different patch sizes

Original Image

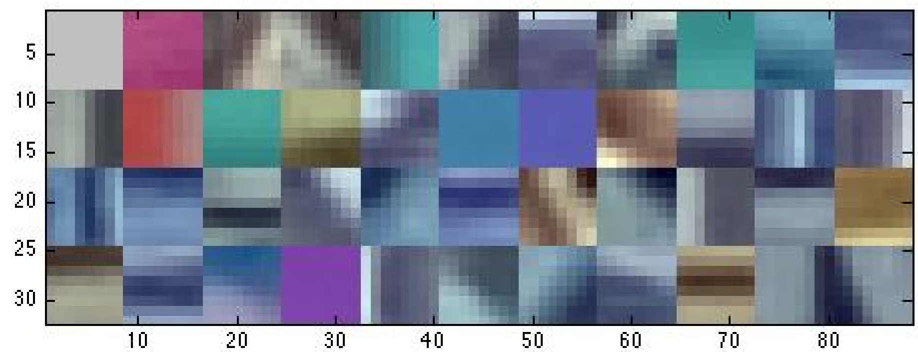
5 X 5 (PSNR = 24.7722)	8 X 8 (PSNR = 25.8896)
	

8*8 represents the image details better.

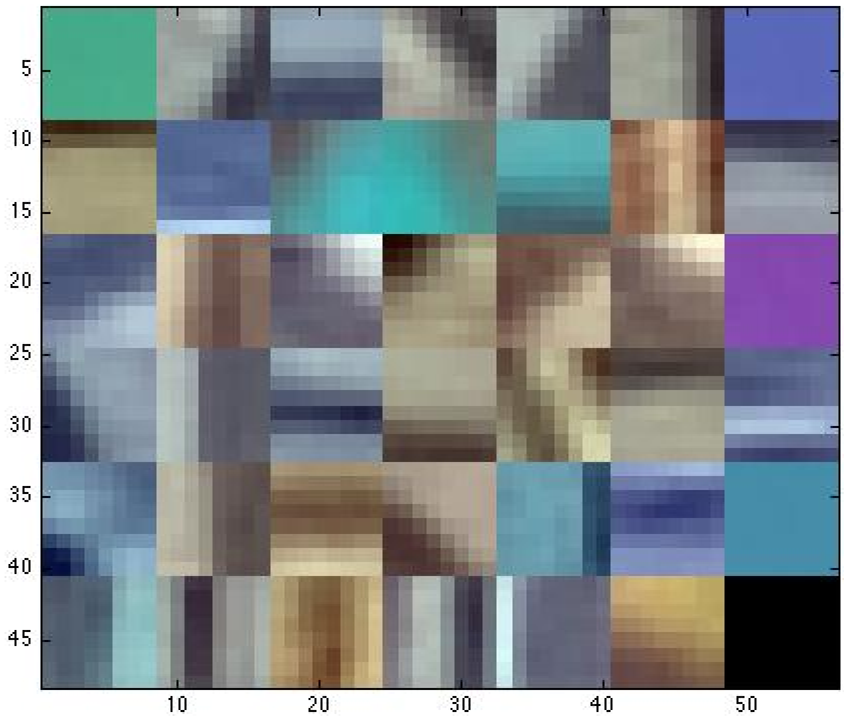
Effect of gamma

Dictionaries:

Gamma=0: (more gray atoms)



Gamma=35: (less gray atoms)



We are learning using the same global dictionary, 42 atoms of 5 X 5 X 3 each.
Original:

0 (PSNR = 24.7722)	35 (PSNR = 24.9875)
	

Gamma=0 has washing out effects which can be seen in the following image.

Original	Gamma = 35	Gamma = 0
		

Single channel denoising vs multichannel denoising

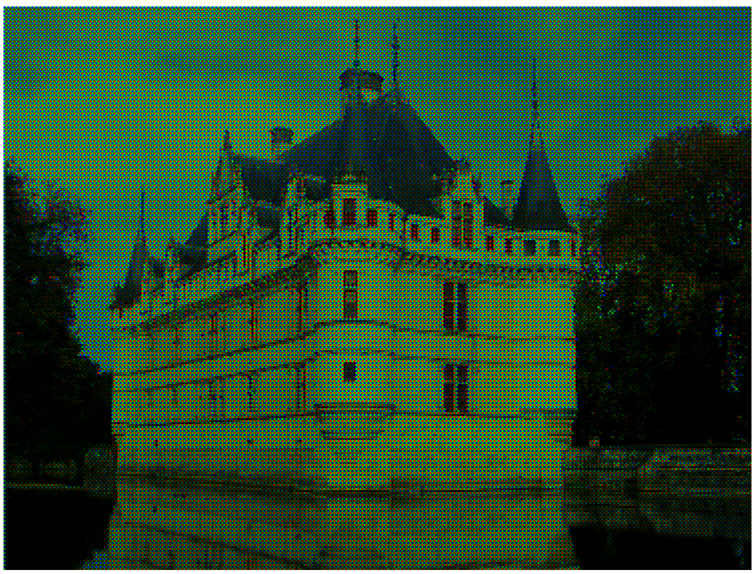
Single Channel (PSNR = 23.4103)	Multichannel (PSNR = 25.8896)
	

If we handle all channels separately and learn a dictionary over them individually, correlation is not taken into account and hence image details are lost.

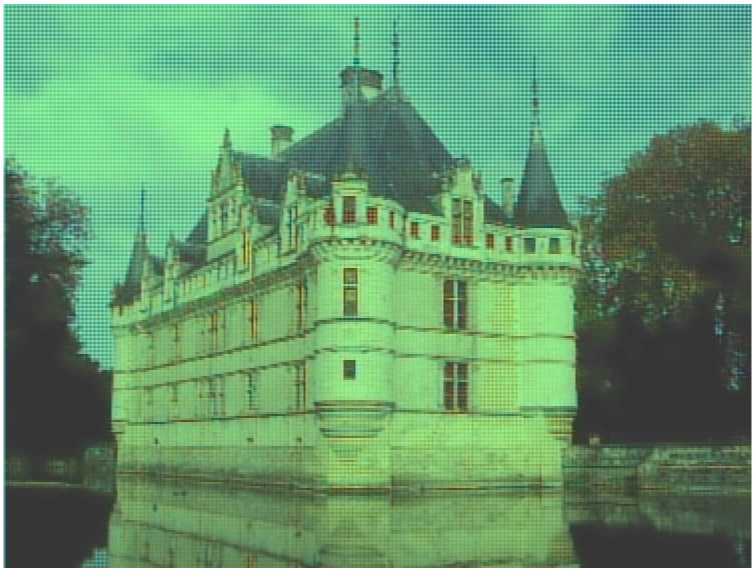
Image Demosaicing

Algorithm: We have just put zeros in holes and used our regular denoising algorithm.

Experiment:



PSNR: 7.9190 for reconstructed image



References

1. SPARSE REPRESENTATION FOR COLOR IMAGE RESTORATION By Julien Mairal Michael Elad and Guillermo Sapiro, October 2006
2. Dictionary Learning based Color Demosaicing for Plenoptic Cameras by Xiang Huang, Oliver Cossairt