

COL 783

Assignment 5

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2017CS10416

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Texture Synthesis

Overview

We were tasked with implementing algorithms which are used in generic texture generation. It was an exciting assignment, where we came across various methods, set on different principles and progressive improvements.

We used random phase shifting to try out changes in frequency and thus random edge shifts. We also tried matching pyramids of random noises with original templates getting the desired textures from the noise.

Also, finally, we took the rigid, brute method for neighbourhood matching and texture generation. We exploited the fact that textures are locally repetitive.

Random phase noise

The simplest approach is based on Fourier descriptors, i.e. the amplitudes of the Fourier coefficients of the image. Creating a random image with the same descriptors is equivalent to retaining the Fourier amplitudes while randomizing their phases.

Results

The random phase noise generation of textures, led to promising textures when working with broadly uniform unstructured textures, changing whose phase would only lead to another distribution of the same pattern.

Whenever some structure, even minimal, was observed the texture generated drifted significantly from the original texture.

Results are presented below...

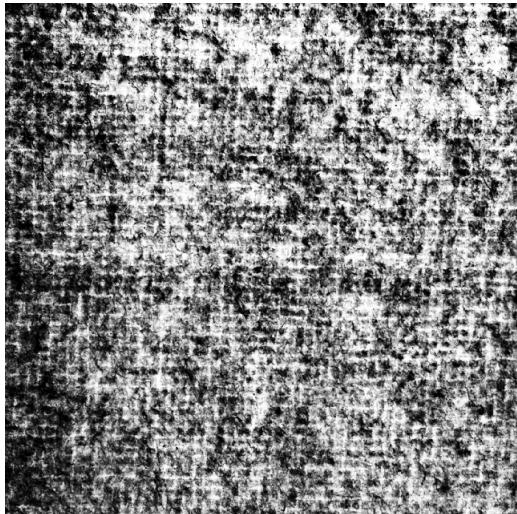


Figure 1: Original

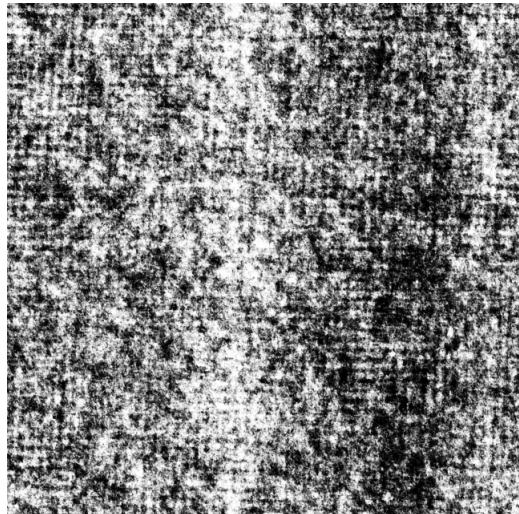


Figure 2: Generated

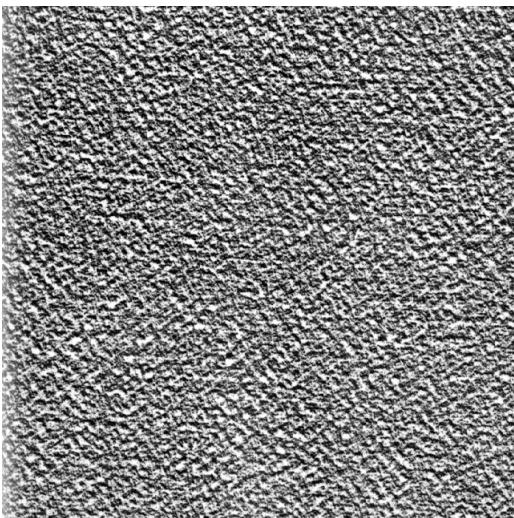


Figure 3: Original

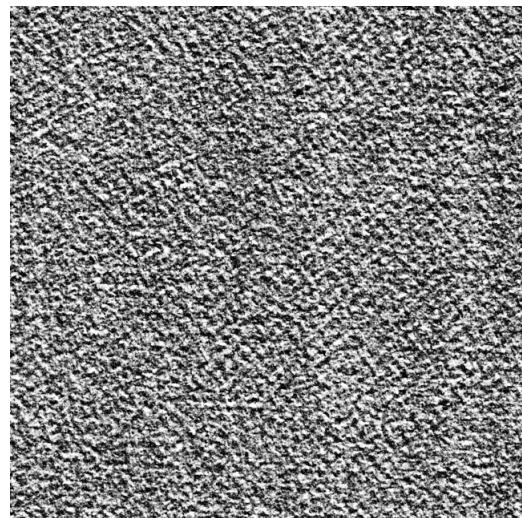


Figure 4: Generated

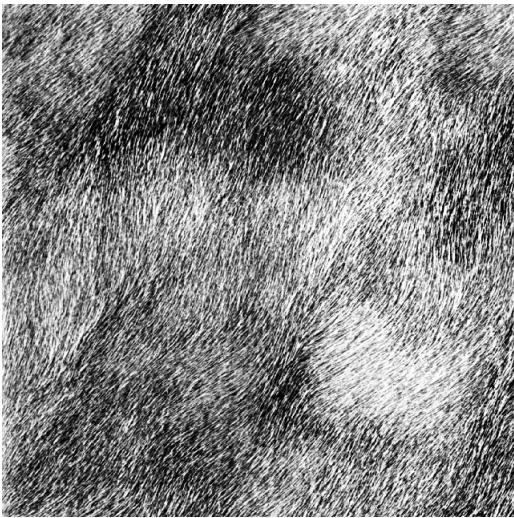


Figure 5: Original

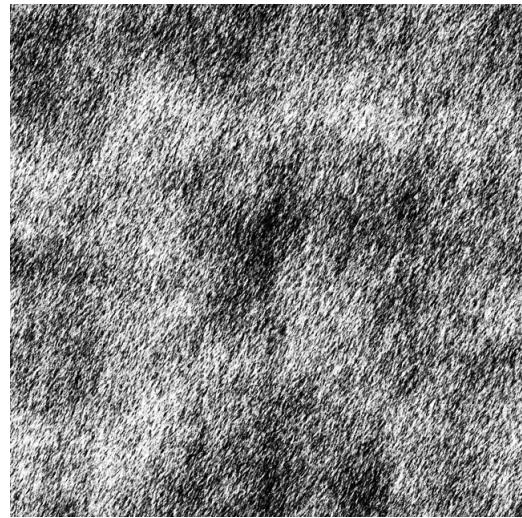


Figure 6: Generated

It is observable that the examples laid lack certain structure.

Also, since, all the examples so far are monochrome there isn't a need to consider the channel interdependence.

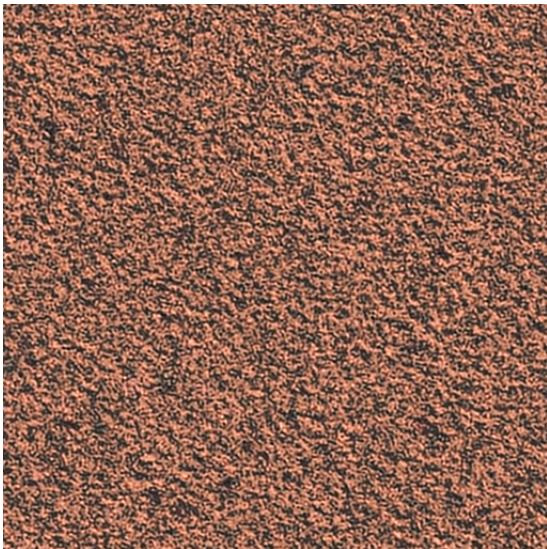


Figure 7: Original

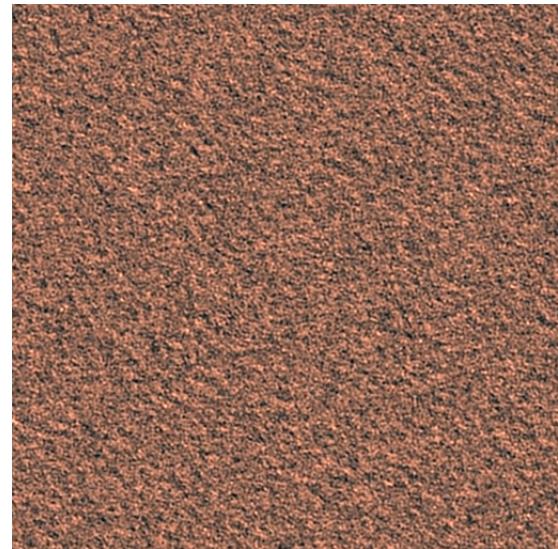


Figure 8: Generated

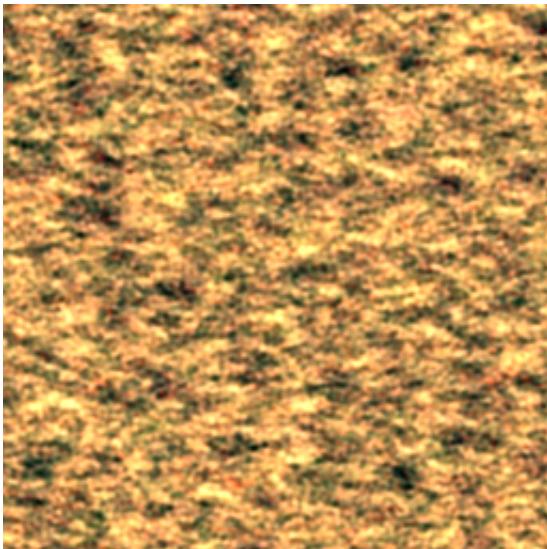


Figure 9: Original

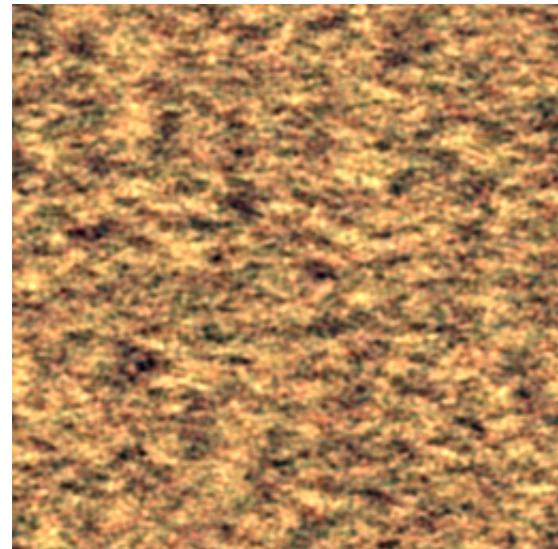


Figure 10: Generated

It is observable that the examples above too, lack certain structure. But there is substantial color-based dependence/correlation.

Now, to maintain such relation while randomising the frequency content, what can be done is converting the image to **YUV** channel (which supports color-independence across channels).

There are multitude of cases where RPN fails to derive the desired results, mostly these arise due to constrained and structured features in the texture which are destroyed by the randomisation.

Few are presented below...

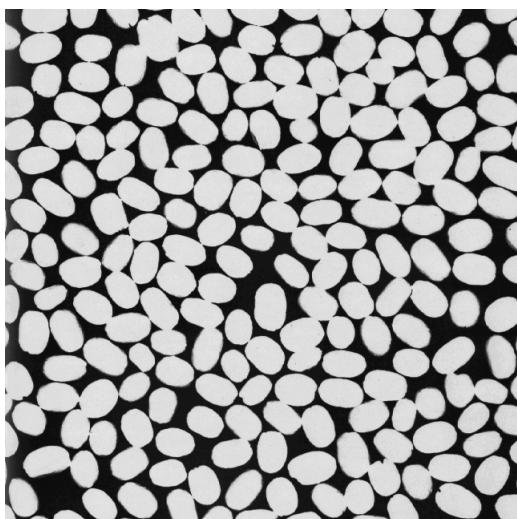


Figure 11: Original

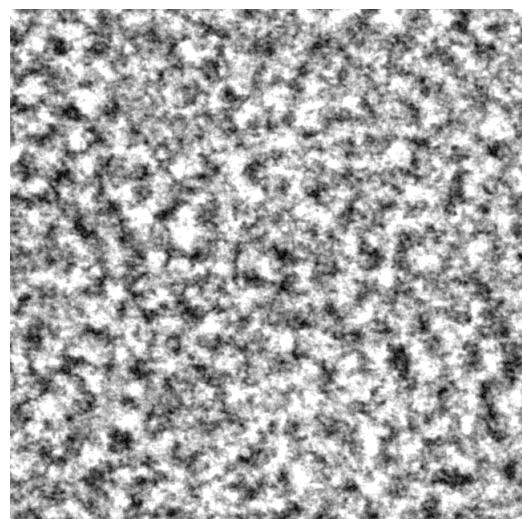


Figure 12: Generated

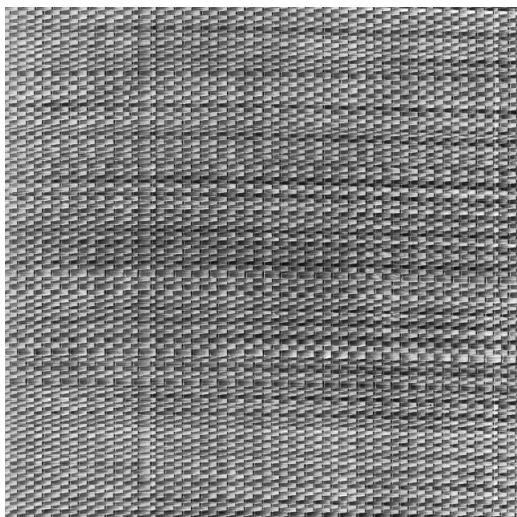


Figure 13: Original

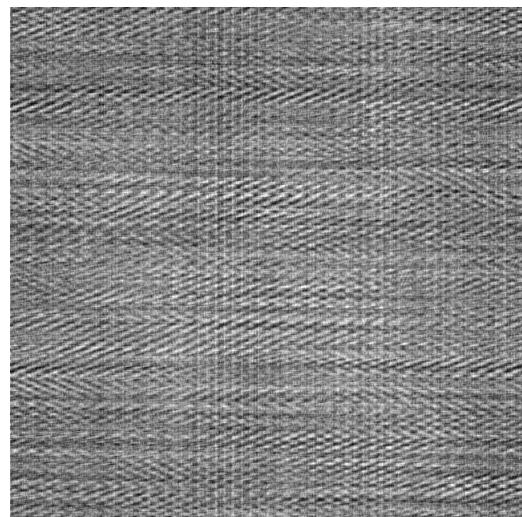


Figure 14: Generated

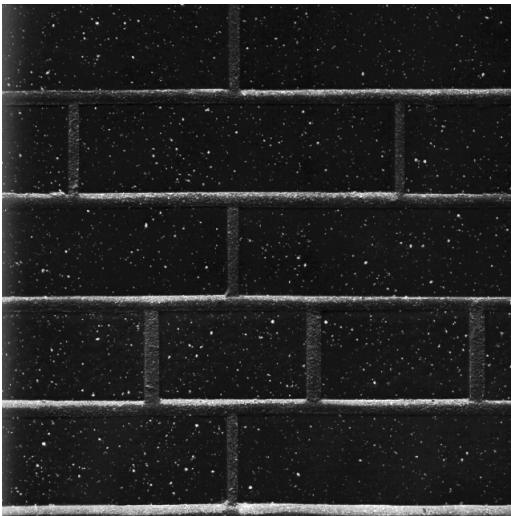


Figure 15: Original

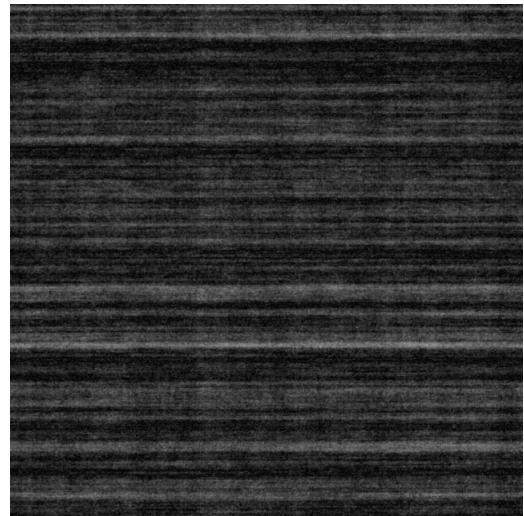


Figure 16: Generated



Figure 17: Original

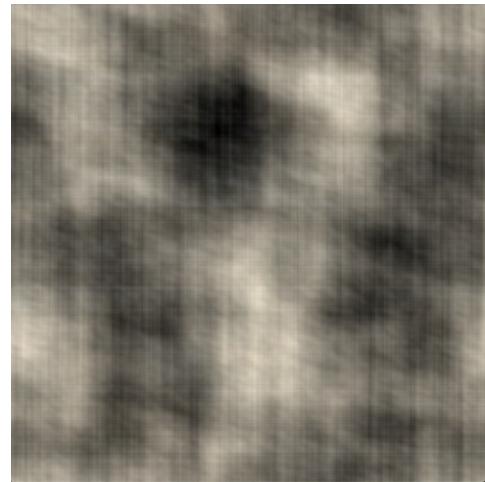


Figure 18: Generated

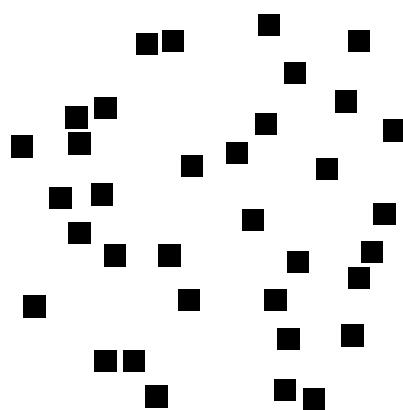


Figure 19: Original

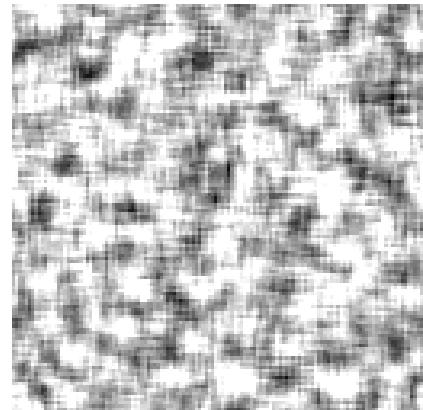


Figure 20: Generated

Steerable Pyramids

Here, starting with gaussian white noise, I was able to reduce them to textures by mapping there steerable pyramids successively till a decent convergence was observed.

The basic motivation is that the steerable pyramids are able to carve out all texture features separately and map them to noise features by histogram matching.

One of the most important things to take care of, while using steerable pyramids on colored images, is to decorrelate the color bands such that the random noise doesn't perturb histogram matching and thus giving vague colorings. This has been shown below...



Figure 21: Image



Figure 22: Generated (No Decorrelation)



Figure 23: Generated (Decorrelation)

Keeping the above formulation in mind, the results are presented below...



Figure 24: Original

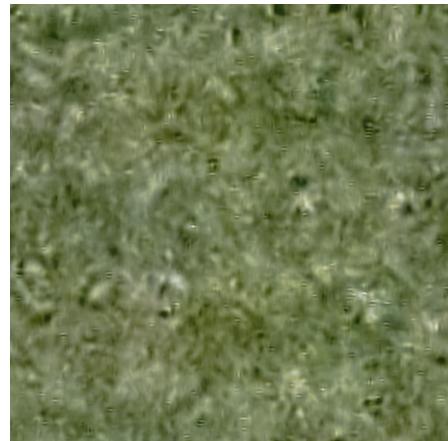


Figure 25: Generated

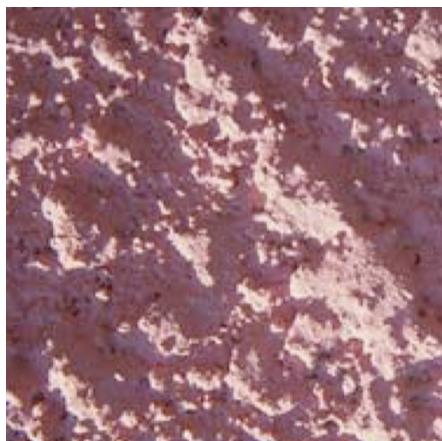


Figure 26: Original

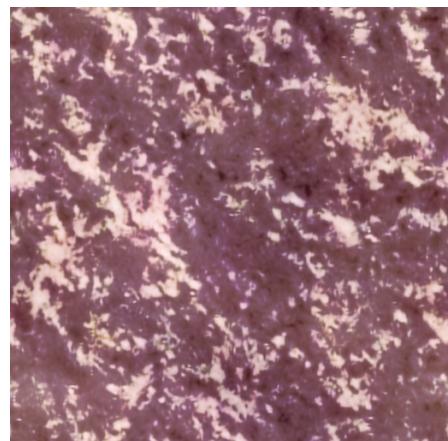


Figure 27: Generated



Figure 28: Original



Figure 29: Generated

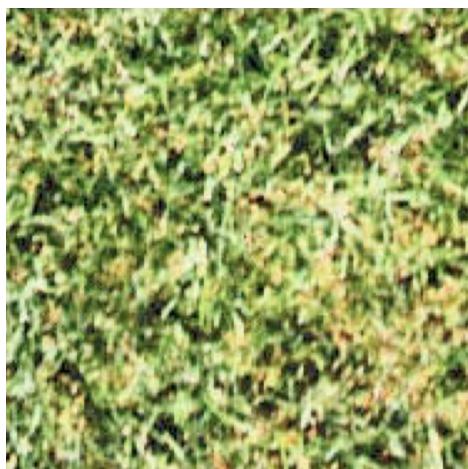


Figure 30: Original



Figure 31: Generated



Figure 32: Original



Figure 33: Generated



Figure 34: Original



Figure 35: Generated



Figure 36: Original

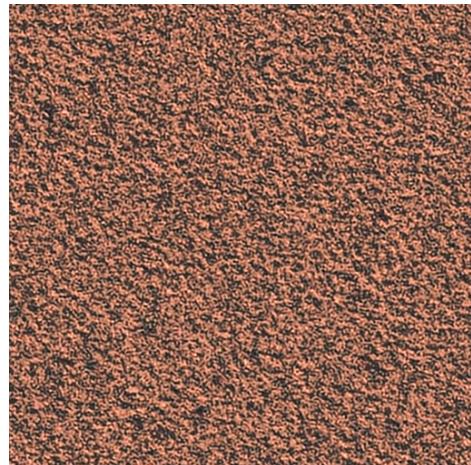


Figure 37: Generated

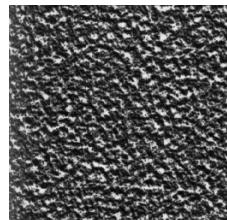


Figure 38: Original

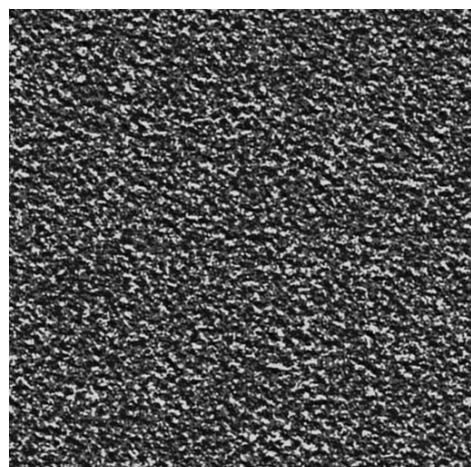


Figure 39: Generated



Figure 40: Original



Figure 41: Generated

The steerable pyramid method works great in many scenarios, giving us very good approximate of textures. But, it fails very bad in case of sharp edges and more-constrained structures, as given below...



Figure 42: Original



Figure 43: Generated



Figure 44: Original



Figure 45: Generated

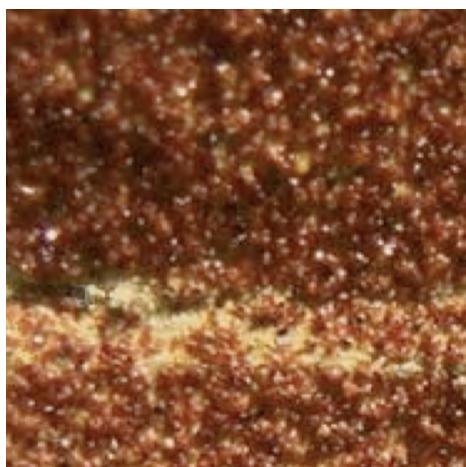


Figure 46: Original

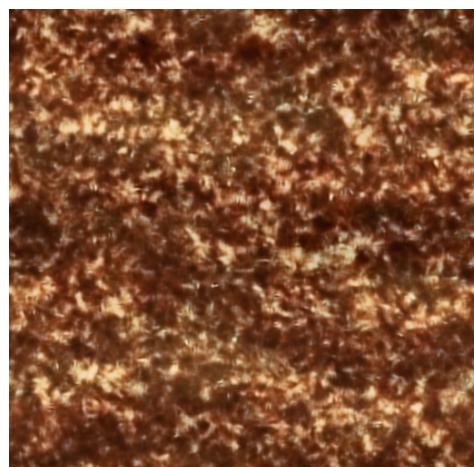


Figure 47: Generated

Non Parametric Synthesis (Bonus)

This method exploits the fact that textures are locally repetitive, and thus allowing neighbourhood matching get the ideal extensions to boundary pixels.

I have picked a generic 2D matrix to represent my neighbourhood (depending on vertical/horizontal extension).

Now, to extend an image, I just fill the image horizontally and then extend it vertically downwards.

Since, no apt optimisations were performed the process was very compute intensive and time consuming.

Results were very promising and are presented below.

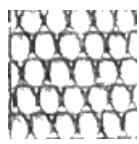


Figure 48: Original

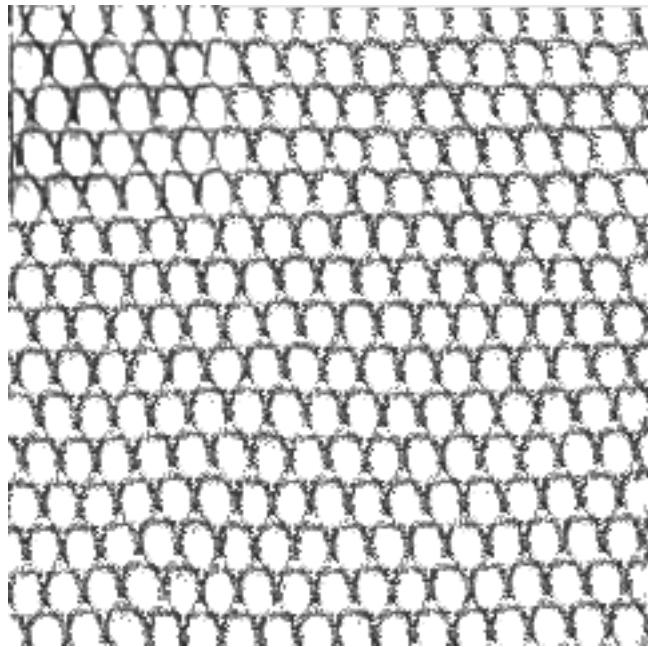


Figure 49: Generated

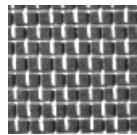


Figure 50: Original

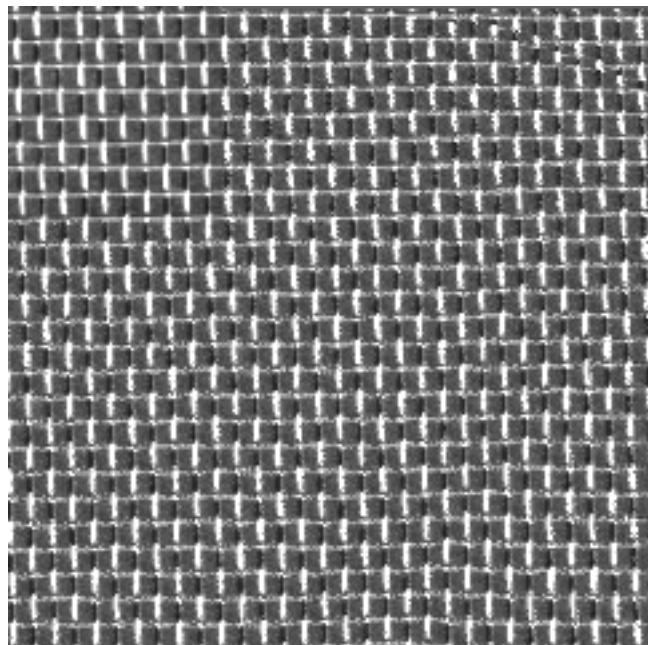


Figure 51: Generated

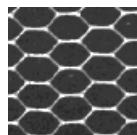


Figure 52: Original

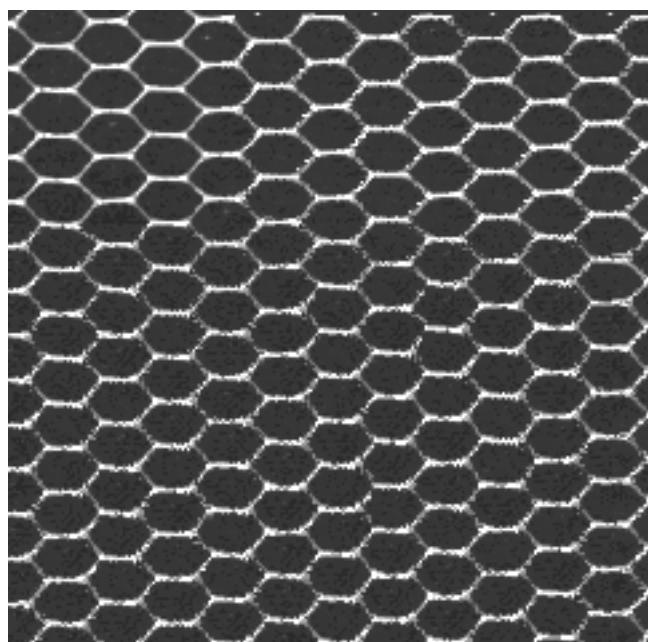


Figure 53: Generated

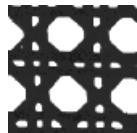


Figure 54: Original

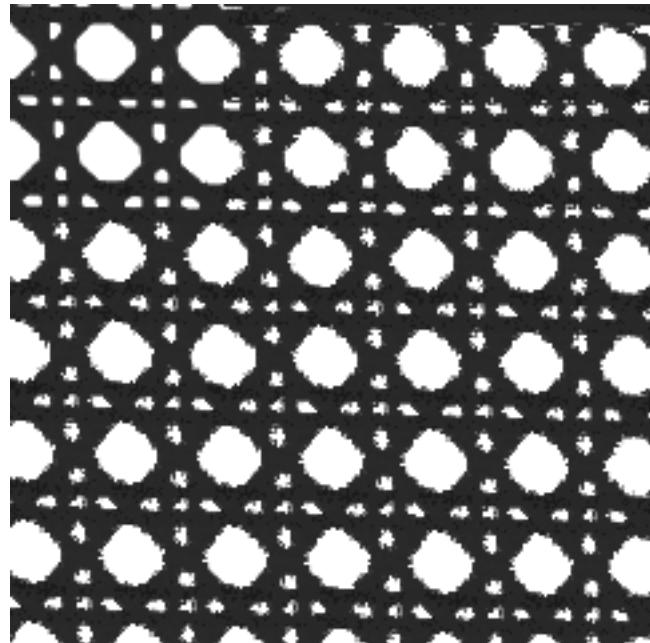


Figure 55: Generated

The results (so far) work very well with almost any filter size, since the feature repetition is periodic. Whereas, such is not always the case and a poor filter choice might lead to a structurally correct yet irrelevant image. Consider below for instance.

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viving rooms," as Ho
escribed it last fall.
t he left a ringing c
ore years of Monic
inda Trino?" That no

Figure 56: Original

ut it becomes harder to find itself, at "this
viving rooms," as Ho
escribed it last fall.
t he left a ringing c
ore years of Monic
inda Trino?" That no

Figure 57: Generated

Summary

This assignment was very interesting, and I learnt a lot of new things.

Covering all the aspects of texture recognition, I feel very confident in the idea and its relevance.

I'd love to pursue it further as well. I am grateful for having been introduced to such an interesting topic.

What was discussed in class was very helpful and useful.

Thanks and Regards

Rajbir