

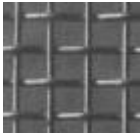
# Assignment 2

## Texture Synthesis

Kshitij Shah – ks1223

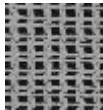
### Part 1: Texture Synthesis

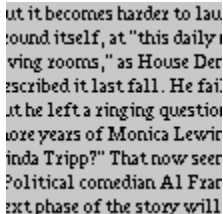
Texture synthesis was performed on windows sizes 5, 9, 11, 13, 15, 17, 19, and 21. A 200x200 image was synthesized with all the above window sizes. Texture 1 and Texture 5 (Text) posited some quality issues. Due to the large size of 'Texton' Texture 1 failed to produce good results for smaller window size. However, with window size of 15 and 17 the results were satisfactory. All the textures improved in quality up to window size 17. Texture 1 degraded in quality after window size 17, other mostly remained the same.

**Texture 1**  


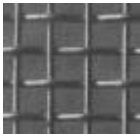
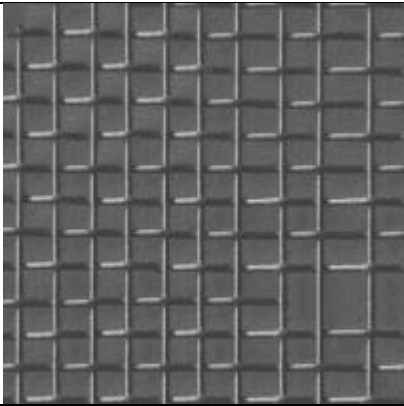
**Texture 2**  

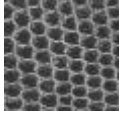
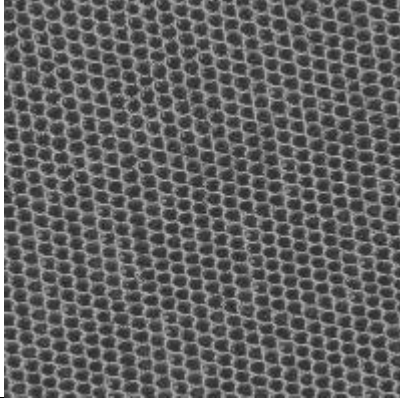

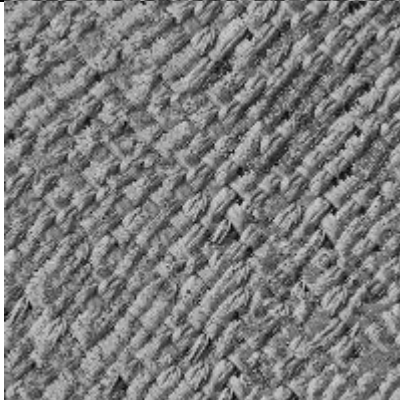
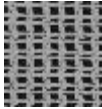
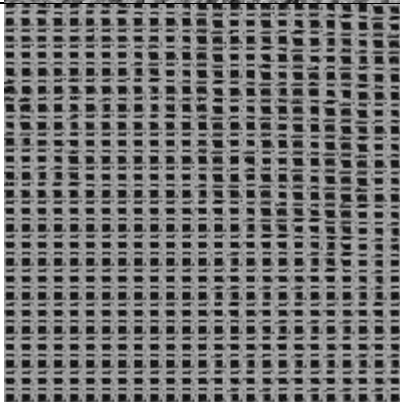

**Texture 3**  


**Texture 4**  


**Texture 5**  


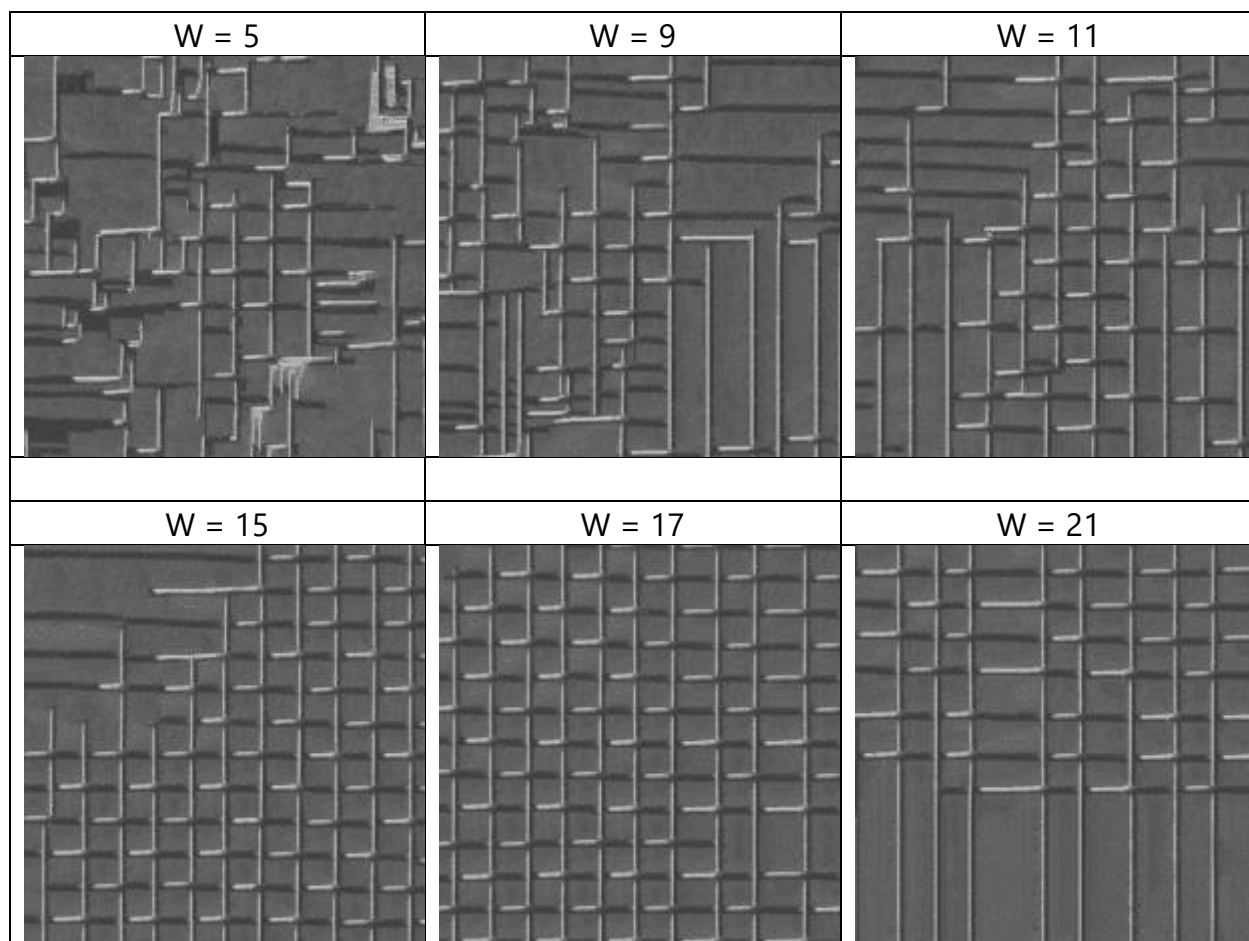
### Best Synthesis for each Texture

Texture	Result	Window size
		17

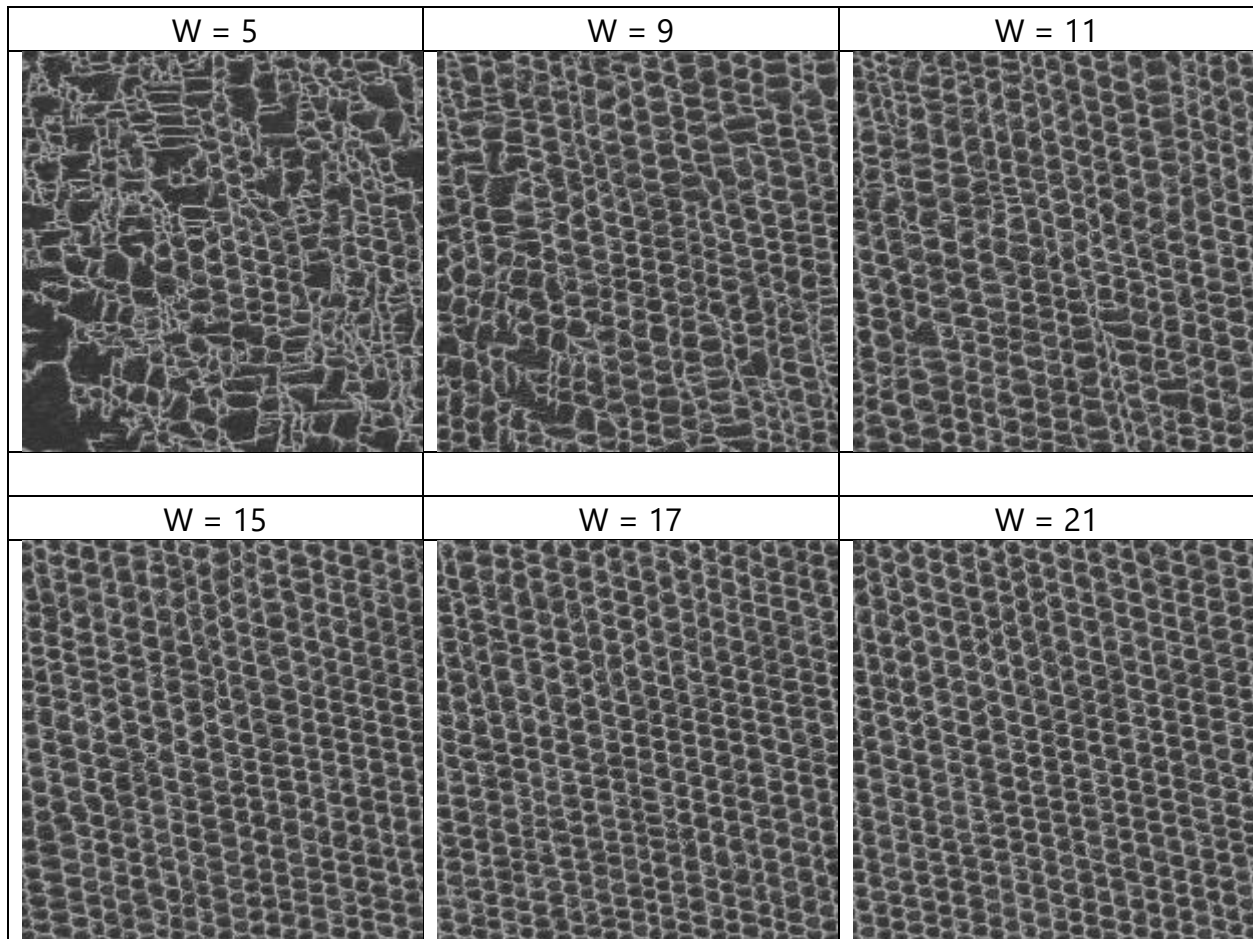
		21
		17
		21
<p>ut it becomes harder to lau ound itself, at "this daily ving rooms," as House Der cribed it last fall. He fal at he left a ringing ques ore years of Monica Lewi inda Tripp?" That now seer Political comedian Al Frar ext phase of the story will</p>	<p>rousel.House Me 1968 Hen Hen Al. Of Hen Hond it last lastical cooond it hedianis Lew the usal itsel. He fal coond itself. Het fall. Fcoq Tal xoonne le fall:" ast fail coonicall. He few self. H a Lestd jtsears datHond itself, at "this dais le left fal lears da ribediang rooms," as House Hefta diao?" ast falh Aluca ribed it last fall. Heft bey fall. lit fall. He fal cone left a ringing ques on A his of Monicall. House years of Monica Lexflow a ring quinow se years da Tripp?" That now s da x comf e se yeae fat ng litical comedian Al Fous ll, dat. gtimeat "the lomest hnd rft a rooo?" Hof est as coms Hoomew self, at Homs omed it l l He dianis of, a ringing rooms," ast helf LFndew s om oing roomed it ribed it last fal. House Al f ring lelt ribed itica zthe left a ringing ind rft l f ring roo roomed itis ow se years of Monicars one yeang ro</p>	21

## Detailed Synthesis Results

Texture 1

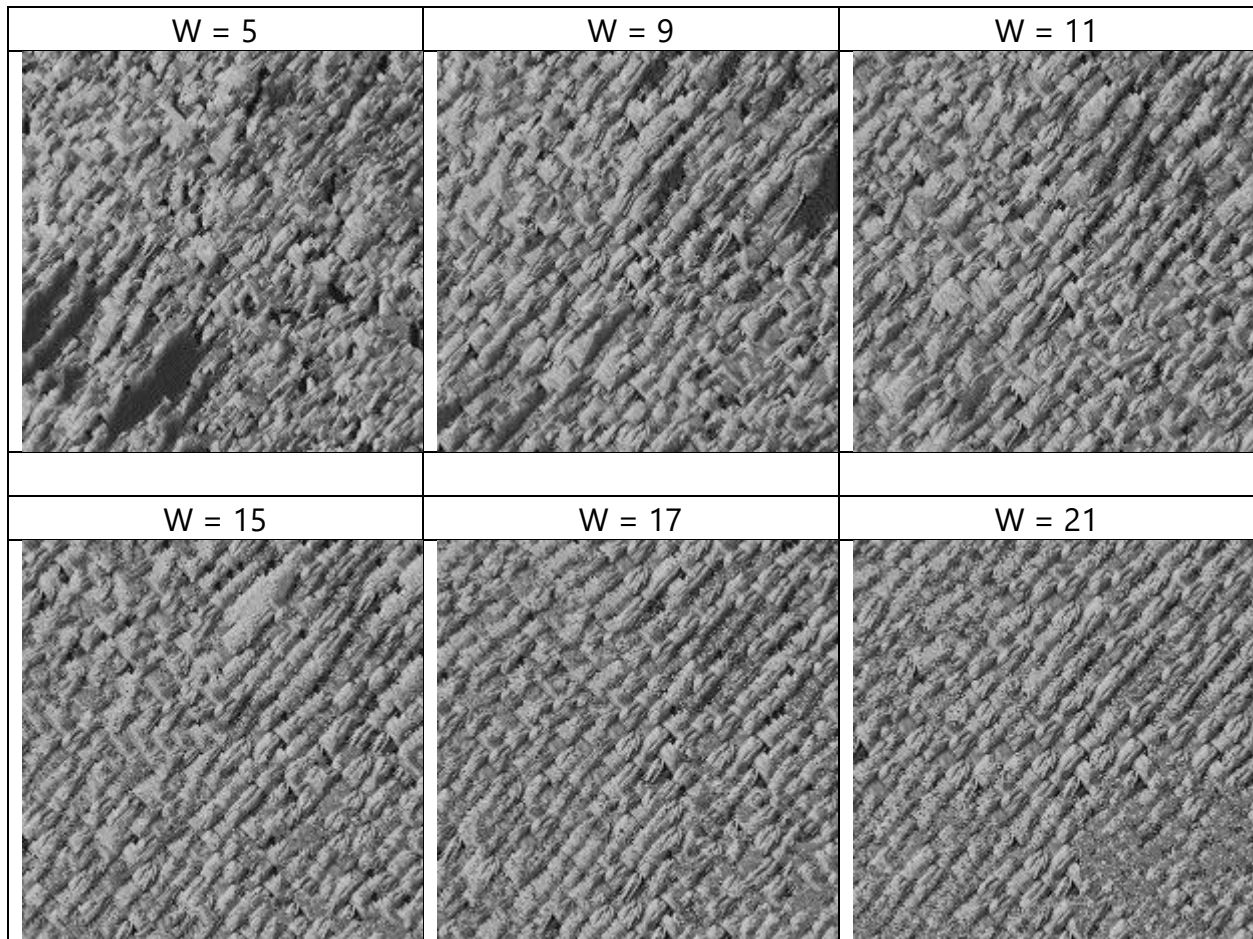


## Texture 2

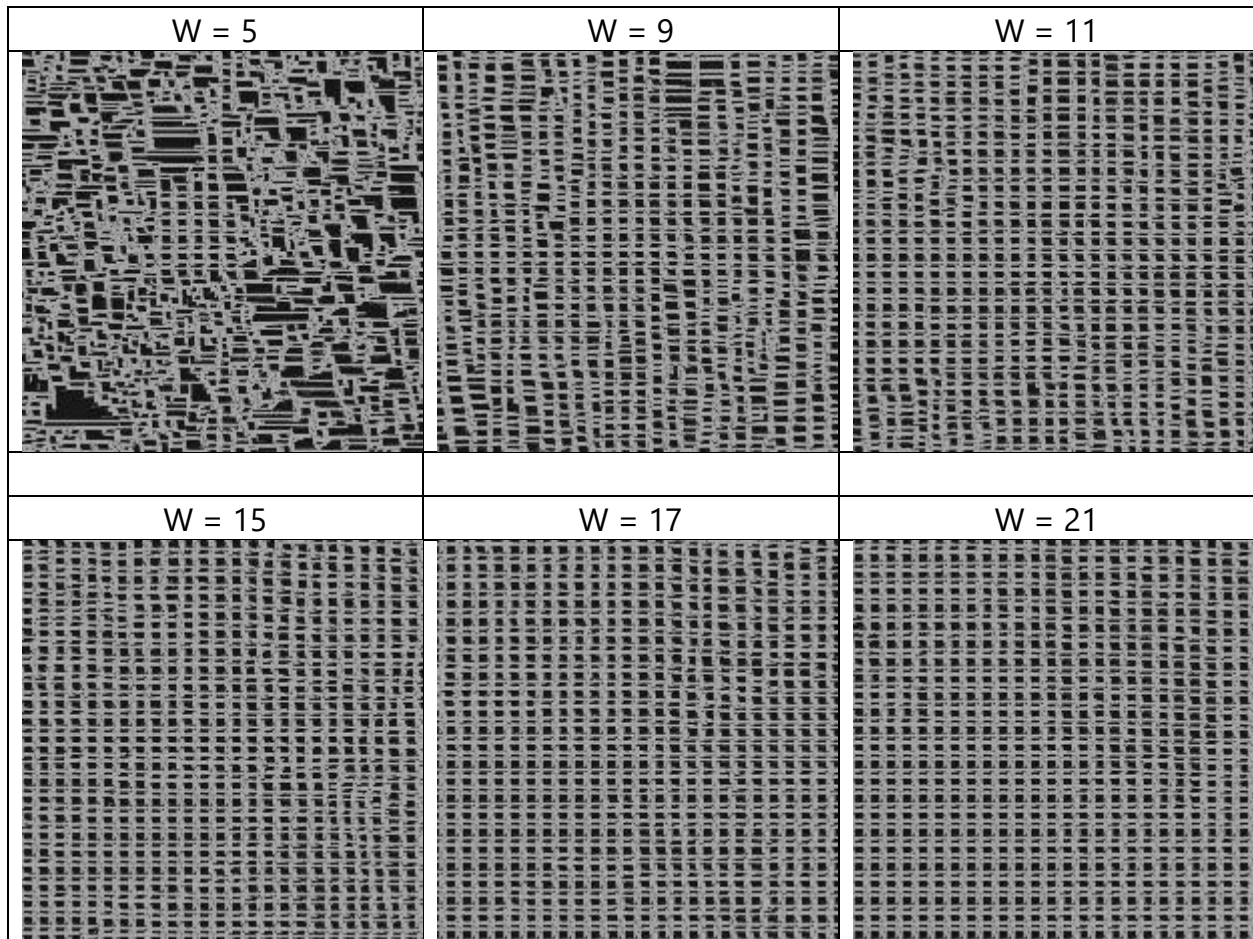




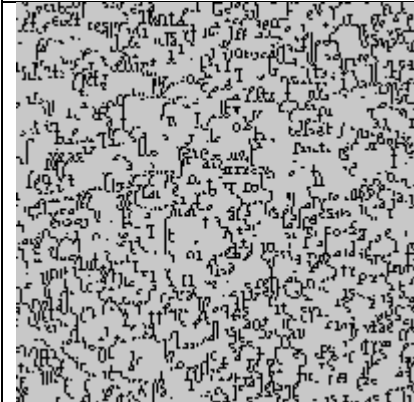

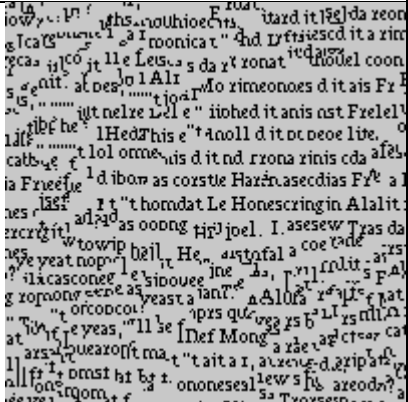
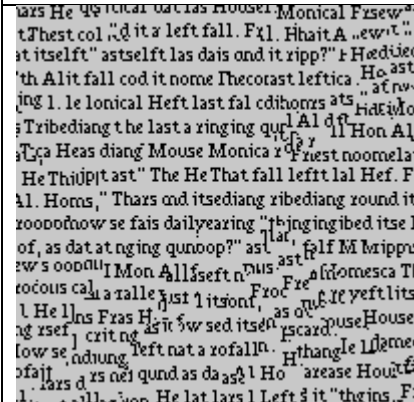
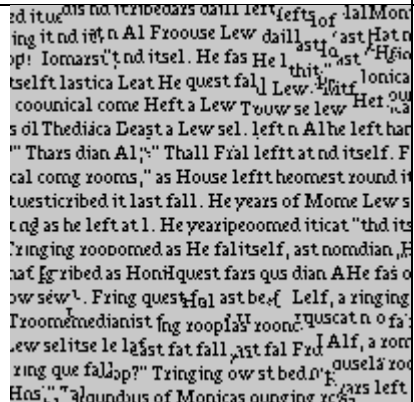
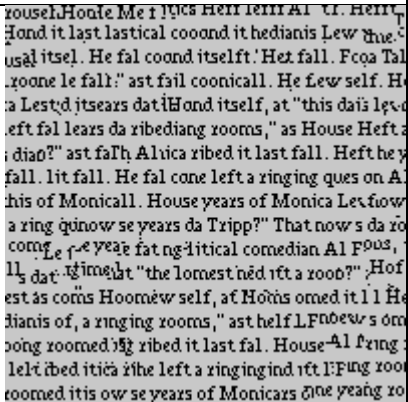
## Texture 3



## Texture 4



Texture 5

W = 5	W = 9	W = 11
		
W = 15	W = 17	W = 21
		



## Part 2: Image Inpainting

### Original Images

Test Image 1










Test Image 2





## Results





Window size	Test Image 1	Test Image 2
5		
9		





11		
15		

### Size Reduction to improve speed

Because of the large size of sample, which is the original image. The algorithm is quite slow. I improvised it a bit by resizing the sample to achieve speed up. The result of course deteriorated, but was acceptable in some cases.

Here are the results,

Window size	Test Image 1	Test Image 2
5		
9		

11		
15		

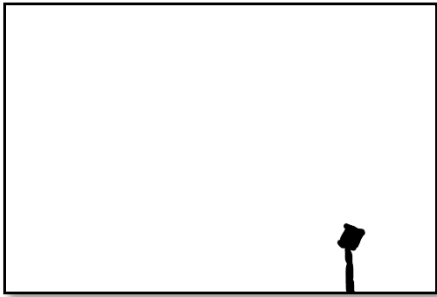


### Part 3

Creminis' approach uses techniques to carefully chooses the order in which pixels are synthesized. Hence, gives better results with object removal. Here are the results from Creminis' algorithm.

#### Test image with board removed

Mask

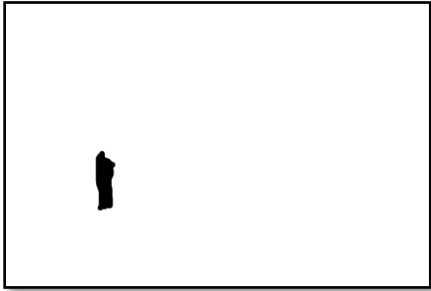


Image



Test image with man removed

Mask

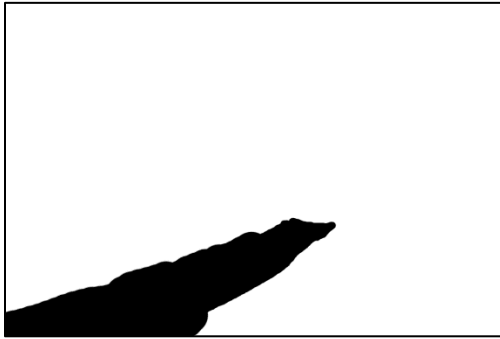


Image



Test image with saturated area removed

Mask



Image



Saturated area removal generated unsatisfactory results.

### Comparison with Efros and Leung

Criminisi's algorithm performs better than Efros and Leung's method as it preserves the dominant edges in the image. Also because of the path based approach it's faster and does not introduce blur like Efros algorithm.

Due to the size of test image 3, Efros and Leung's approach is computationally infeasible for it. Criminisi's approach can handle such sizes and gives plausible results.



## Part 4: Image Quilting

It is obvious from the beginning that texture synthesis using Efros and Leung's method would be slow. The reason is it constructs texture pixel by pixel. It would be better if the unit of construction would be a patch rather than a single pixel.

Efros and Freeman's approach does exactly the same. Picking up patches at random from the sample and putting them on the output image. However, to make texture consistent patches needs to be overlapped. This overlapping is done in a manner that the difference between overlapped region of patches (error) is minimized.

### Running Time

With large patch size and high error threshold this algorithm is significantly faster. In my test runs the time taken to synthesize similar quality textures were improved by a factor of 2. For sensitive textures like text, the running time was not improvement was less.

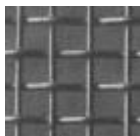
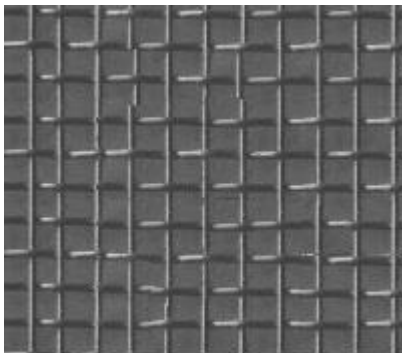
### Quality

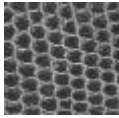
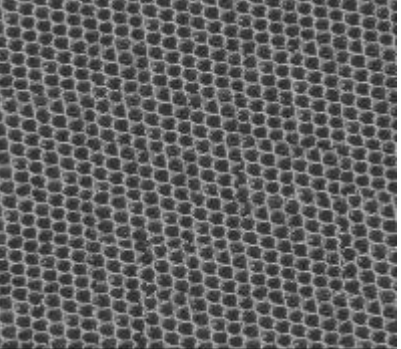

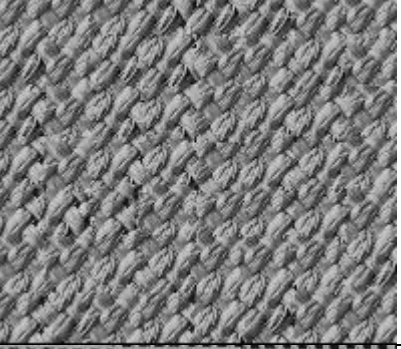
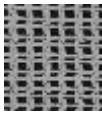
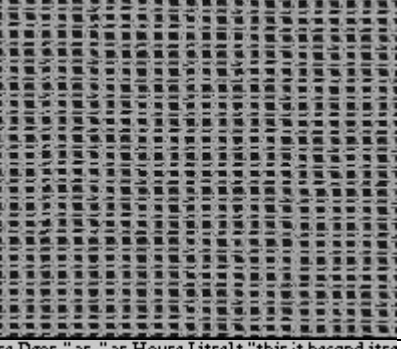
This approach produced slightly better quality textures, especially for texture 1 and 5. For texture 1 the issue of missing lines present in the first approach was no longer there. However, there were broken lines where the patches overlap.

### Takeaway

This approach is an improvement over the first one. However, the patch size and error threshold needs to be carefully chosen to get the desired quality, while still keeping the running time less.

### Results

Texture	Result	Patch size
		25

		25
		25
		25
<p>ut it becomes harder to lau ound itself, at "this daily wing rooms," as House Der scribed it last fall. He fai ut he left a ringing question ore years of Monica Lewi inda Tripp?" That now seer Political comedian Al Fra ext phase of the story will</p>	<p>se Dens," as "as House l itself "this it becond itse He fai last last fall. He roomas Hound itsag roor et he lquestic left a ringida Tripuse L Houseooms," ore yea Lew-years of Molitical. He fall. Hd it las ole Years or MonifseIt, at 'unseir, at 'uns singin inda Tripp?" That ooms," as Horns," as Hoof Mon polstiques inquesitived now be a hng, "33 Bi Thor a Lewa Lewa Lewone left Al Fxs of Mast fa?" That ow seww seww seengrungnigths," as a s ranoordi; Al Fr Al Fr Al Fr xibed Monid last if, at "ed it la nz w'lonics' roordis be l f hazon ringitnes fuball. Xi Al Piat noed it se left at "thibf Melf, at ing que onz urben it' fta: years," at "in"" "thi-," an iars an Ale left comedizself, z, "as E., as Horns," : Tripp story years f the soms. "ast fal</p>	25

The results were obtained using the code from <https://github.com/afrozalm/Patch-Based-Texture-Synthesis>

## Reference

1. <http://graphics.cs.cmu.edu/people/efros/research/EfrosLeung.html>
2. <https://github.com/afrozalm/Patch-Based-Texture-Synthesis>
3. A.A. Efros and W.T. Freeman, Image Quilting for Texture Synthesis and Transfer, SIGGRAPH 01.
4. <https://www.microsoft.com/en-us/research/publication/region-filling-and-object-removal-by-exemplar-based-inpainting/>