IMAGE QUILTING

Texture Synthesis and Transfer

COURSE PROJECT CS663

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CONTENTS

PREVIOUS WORK

- Bela Julesz suggested that two texture images will be perceived by human observers to be the same if some appropriate statistics of these images match. This suggests that the two main tasks in statistical texture synthesis are (1) picking the right set of statistics to match, (2) finding an algorithm that matches them.
- Heeger and Bergen proposed to analyze texture in terms of histograms of filter responses at multiple scales and orientations. Matching these histograms iteratively was sufficient to produce impressive synthesis results for stochastic textures.
- By matching these pairwise statistics, Portilla and Simoncelli were able to substantially improve synthesis results for structured textures at the cost of a more complicated optimization procedure.

PROBLEM STATEMENT

Texture Synthesis : Synthesising new image is by stitching together small patches of existing images. This process is called image quilting.

Texture Transfer : Extend the algorithm to perform texture transfer – rendering an object with a texture taken from a different object. Re-rendering an image in the style of a new image.

Data

We have implemented the algorithm described in the following paper.

Efros, Alexei A., and William T. Freeman. "Image quilting for texture synthesis and transfer." Proceedings of the 28th annual conference on Computer graphics and interactive techniques. ACM, 2001.(Link)

For comparing the results, we have used images from the paper itself -

1) Texture Synthesis: Link_1, Link_2

2) Texture Transfer: Link

Texture Synthesis

IMAGE QUILTING ALGORITHM FOR TEXTURE SYNTHESIS

1) Randomly pick a block of user-defined blocksize from input texture and paste it into top left corner of new image

2) Go through the image in raster scan order in steps of block size(minus overlap)

3) For every location, from the blocks' list from input texture pick a block such that it satisfies the constraints on top and left side within some tolerance of error. Randomly pick one of such blocks

4) Compute the surface error between the new block and the old blocks. Find the minimum cost path and paste the new block along that path

Minimum Error Boundary Cut

For calculating the minimum error boundary cut, assume a vertical overlap between two blocks B_1 and B_2, with B_1^{ov} and B_2^{ov} as their overlapping surfaces

The error surface is defined as $e = (B_1^{ov} - B_2^{ov})^2$.

Traverse $e(i = 2,\ldots,N)$ and compute the cumulative mean error E for all paths as

$$E_{i,j} = e_{i,j} + min(E_{i-1,j-1}, E_{i-1,j}, E_{i-1,j+1})$$

The minimum value of the last row in E will indicate the end of the minimal vertical path though the surface and one can trace back and find the path of the best.

Similarly the cut for horizontal overlap can be found out.

When there is both a vertical and a horizontal overlap, the minimal paths meet in the middle and the overall minimum is chosen for the cut.

Results Texture Synthesis

Paper Result

Original Texture

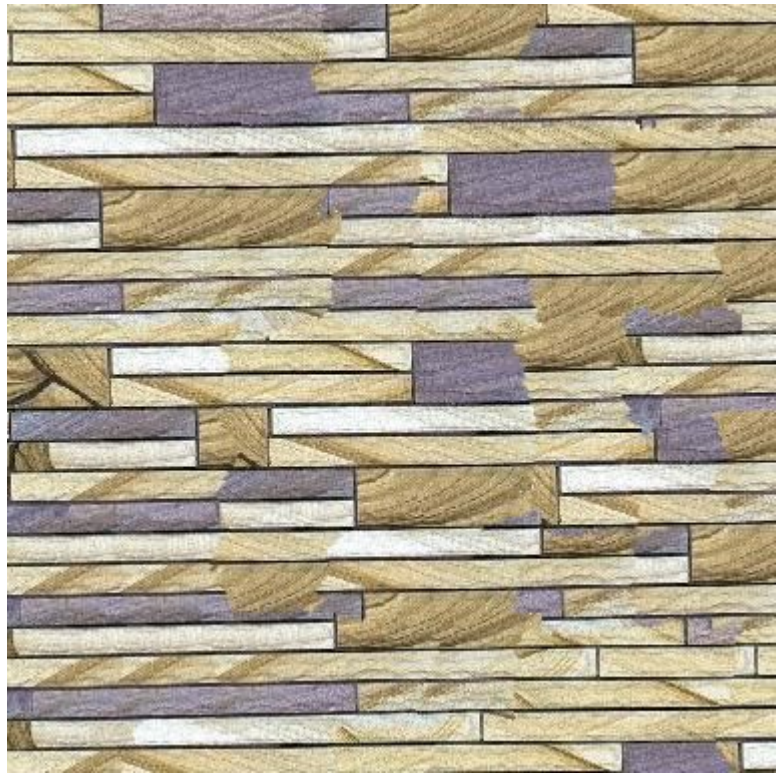
Our Result

Results Texture Synthesis

Block size = 80
overlap = 13

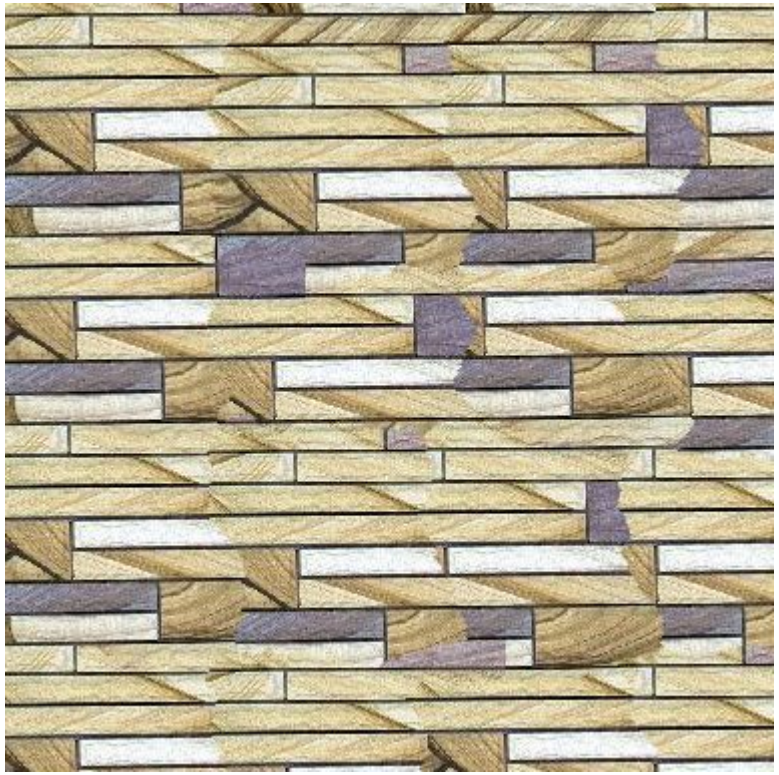
Block size = 100
overlap = 16

Results Texture Synthesis



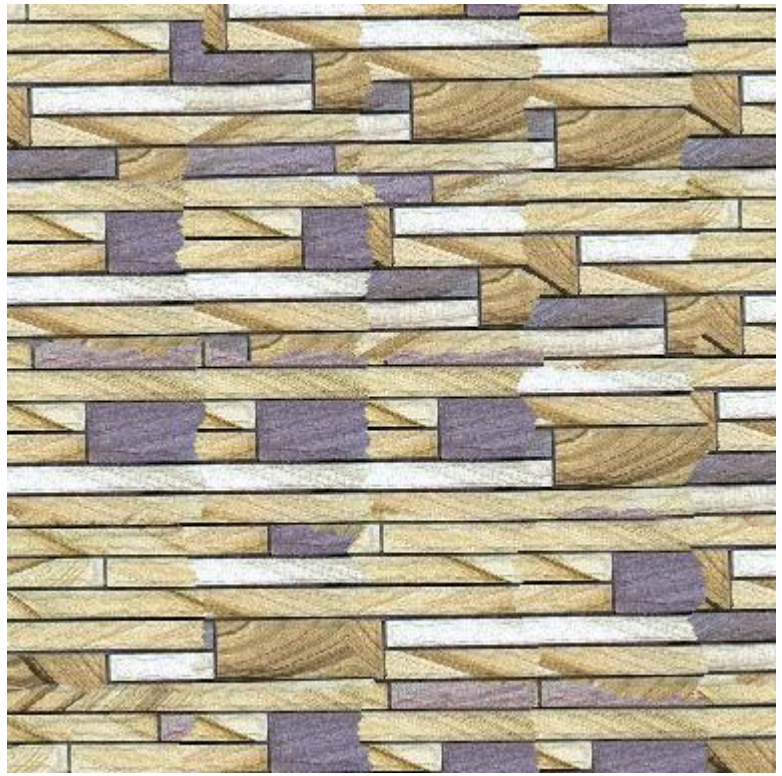
Paper result

Original

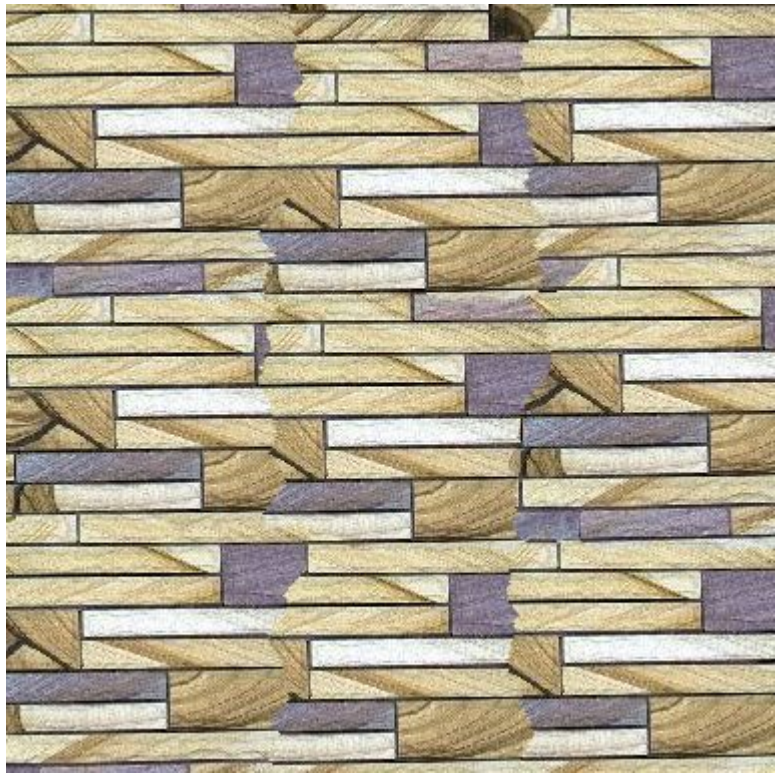


Our Result
Block size = 150
Overlap size =50

Results Texture Synthesis

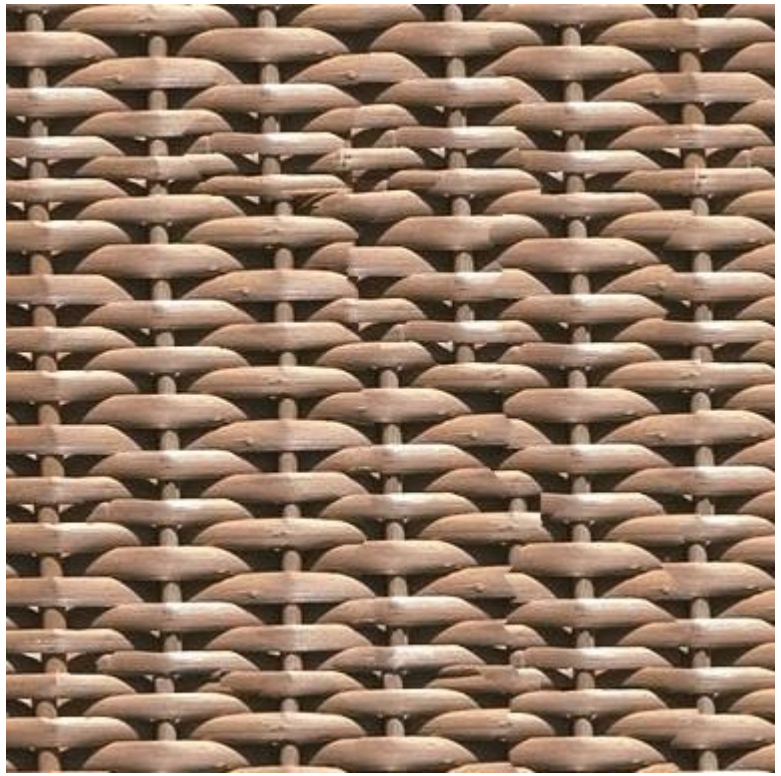


Block size = 100
Overlap size =16



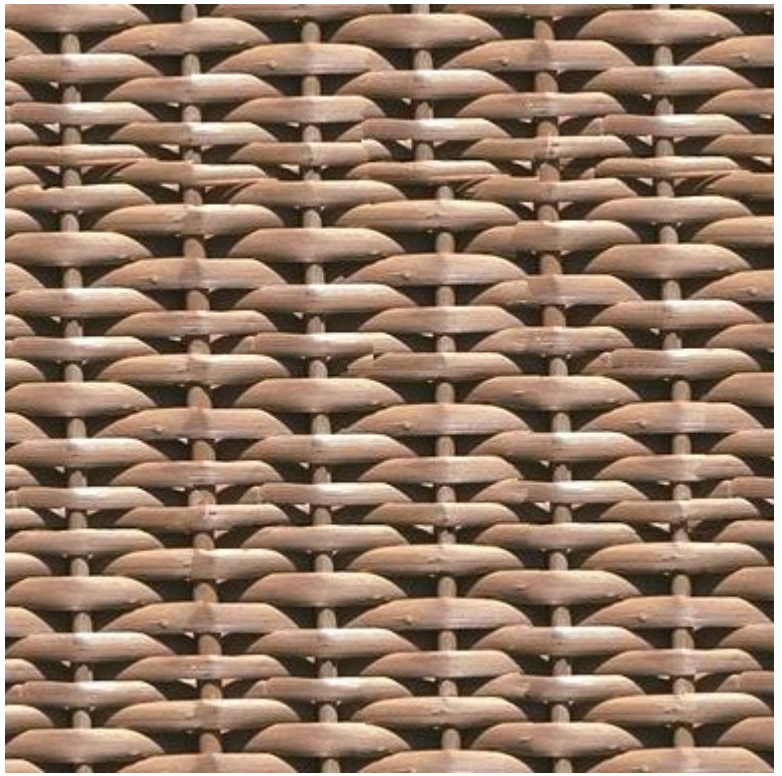
Block size = 150
Overlap size =25

Results Texture Synthesis



Paper Result

Original Texture



Our Result

Results Texture Synthesis

Paper Result

Original Texture

Our Result

Results Texture Synthesis

Original Texture

b=100 o=16 t=0.1

b=50 o=8 t=0.1

b=50 o=20 t=0.1

Results Texture Synthesis

Paper Result

Original Texture

Our Result

Limitation - Excessive Repetition

Results Texture Synthesis

Paper Result

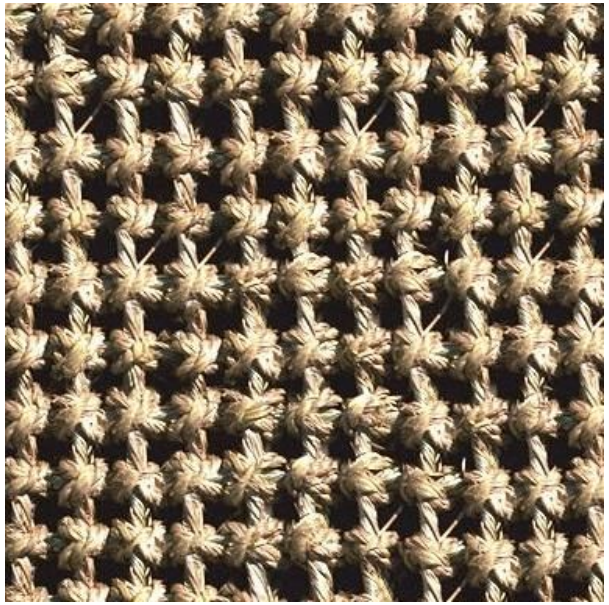
Original Texture

Our Result

Limitation - Mismatched/Distorted Boundary

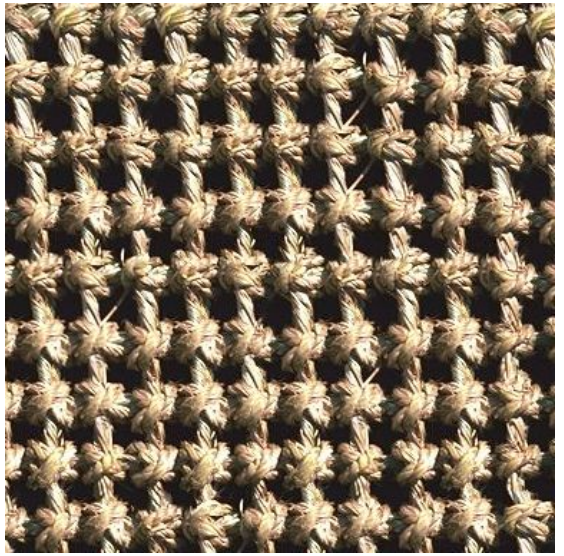
OTHER RESULTS

Results Texture Synthesis



Paper Result

Original Texture



Our Result

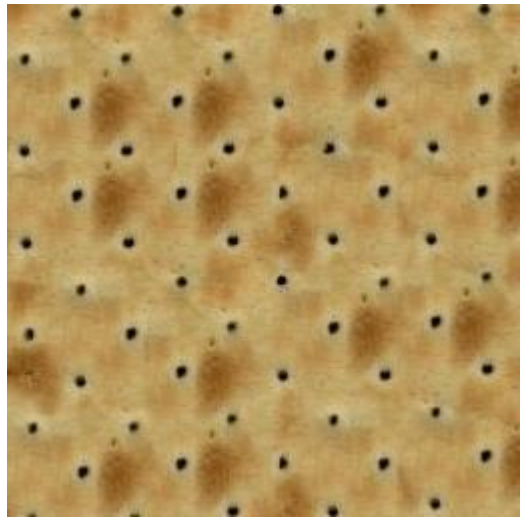
Results Texture Synthesis

Paper Result

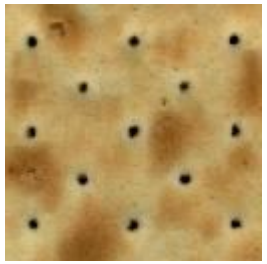
Original Texture

Our Result

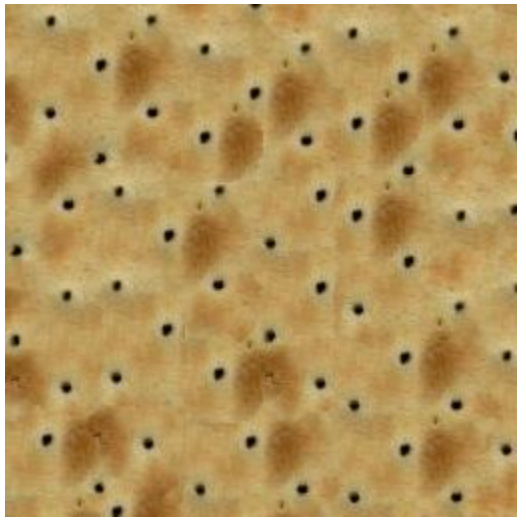
Results Texture Synthesis



Paper Result



Original Texture



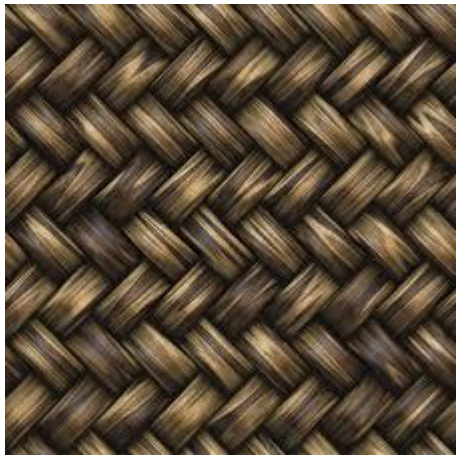
Our Result

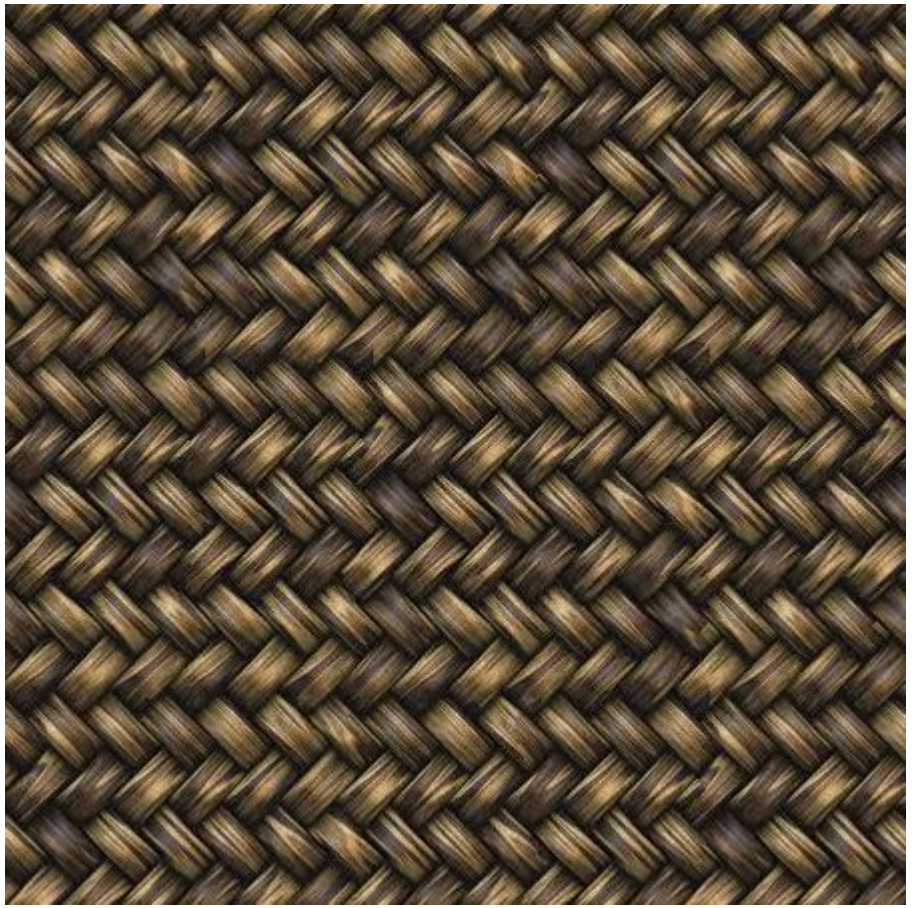
Results Texture Synthesis

Results Texture Synthesis

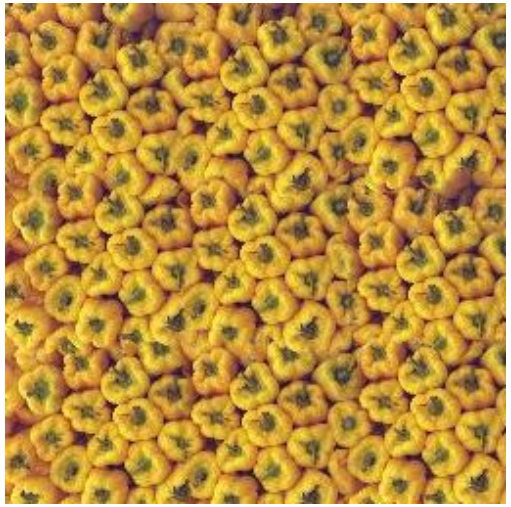
Results Texture Synthesis

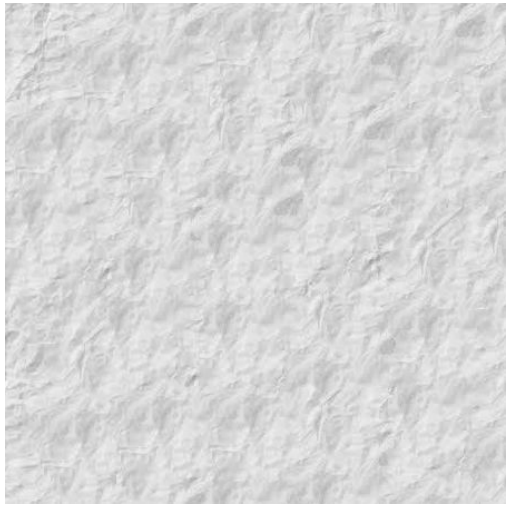
Results Texture Synthesis

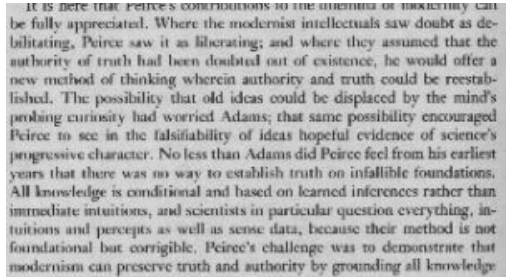


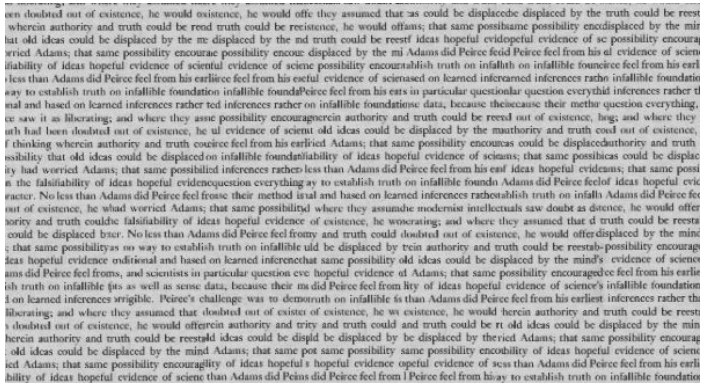


Results Texture Synthesis

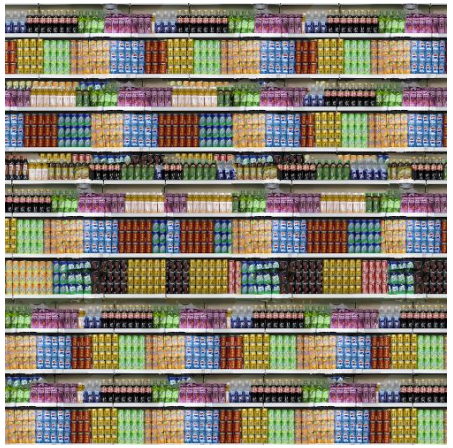








Results Texture Synthesis



Texture Transfer

IMAGE QUILTING ALGORITHM FOR TEXTURE TRANSFER

The image must respect two constraints

1) The output are legitimate, synthesized examples of the source texture

2) The correspondence image mapping is respected.

correspondence maps are the (luminance) image intensities

The error term in image quilting is modified by a weighted sum, ***a*** **times the block overlap matching error plus** ***(1-a)*** **times squared error** between the correspondence map pixels within the source texture block and those at current target image position.

The parameter ***a*** determines the tradeoff between the texture synthesis and the fidelity to the target image correspondence map.

Sometimes a single pass is not enough to create pleasing results, in such case we iterate over the image multiple times reducing the block size with each iteration

The only change from the non-iterative version is that in satisfying the local texture constraint the blocks are matched not just with their neighbor blocks on the overlap regions, but also with whatever was synthesized at this block in the previous iteration.

Results Texture Transfer

Target Image

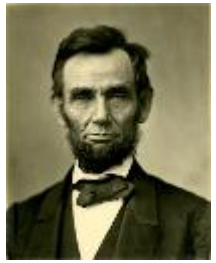
Source Image

Our Results

Paper results

Results Texture Transfer






Target Image

Source Image

Our Results

Conclusions

1.The Image Quilting Algorithm implemented here is a simple patch based synthesis method with remarkable results both with stochastic and semi-structured textures.

2.The block size is chosen according to the texture for best results.

3.Minor Limitations - Mismatched boundaries and excessive repetition.

4.Texture transfer requires computation of another error term so takes more time.

5.Better results for texture transfer can be obtained by multiple iterations and changing the weight alpha accordingly for each iteration.