

Digital Image Processing (CSE 478)

Lecture 22: Content aware image resizing

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Image resizing



We want to perform $1/3^{\text{rd}}$ reduction in width

Image resizing: Cropping



Image resizing (cropping in videos): Pan and scan



Image resizing: Scaling



Image resizing: Letterboxing



Image resizing: Letterboxing



Image resizing: content aware



Image resizing: content aware



Image resizing: content aware



Image resizing: content aware



How do we do it?

Many algorithms.....

We will discuss a particular one today, called seam carving!

Overview: step 1



Compute some sort of importance characteristic: gradient magnitude, entropy, visual saliency, eye-gaze movement



Overview: step 2



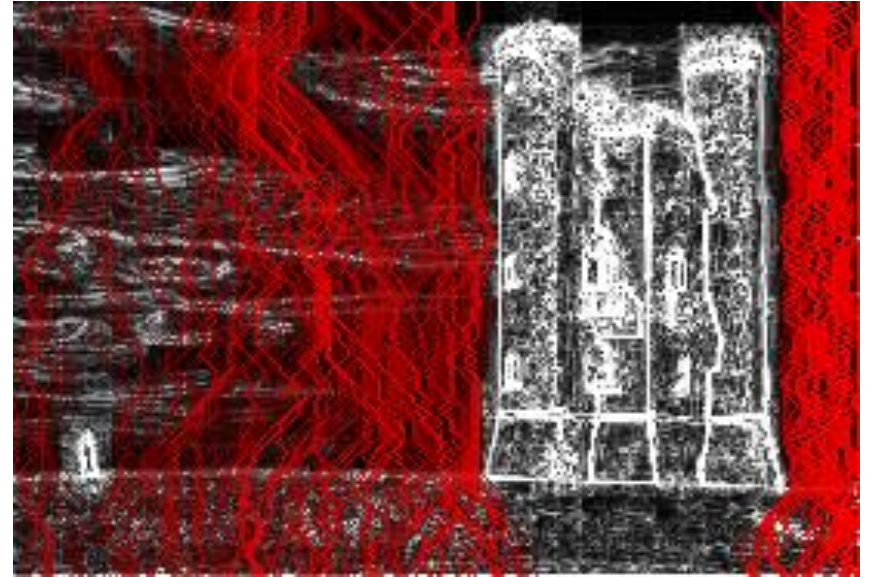
Find the path of minimum cost in the importance image

Overview: step 3



Delete the minimum cost seam

Overview: step 4



Repeat step 1, 2 and 3 until reaching the desired size

Overview: step 4



Repeat step 1, 2 and 3 until reaching the desired size

Video Illustration



How to find the minimum cost seam?



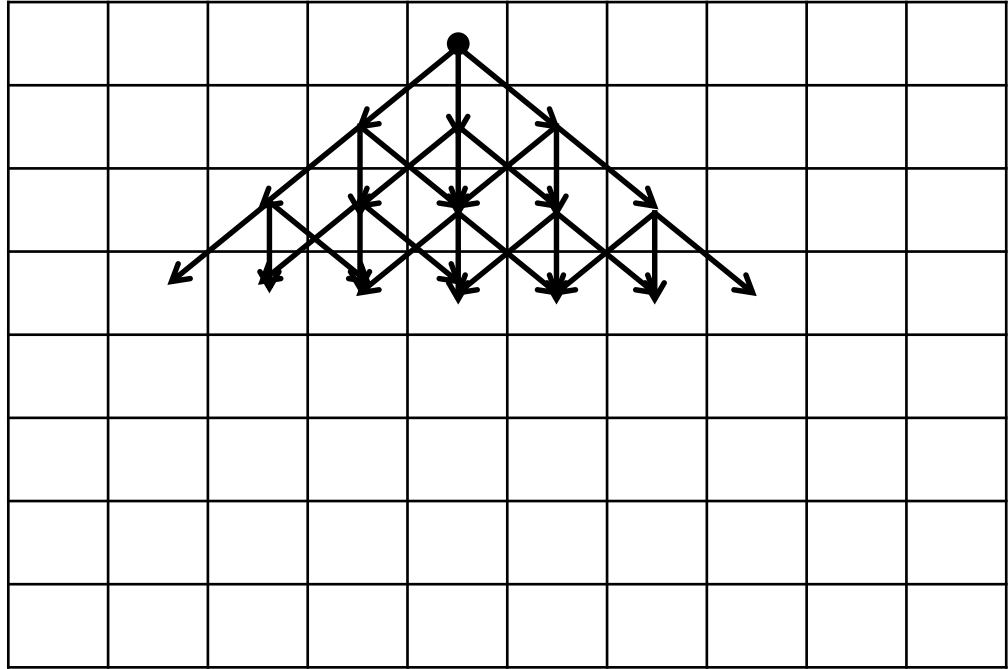
How to find the minimum cost seam?

- Find minimum cost **connected** path from top to bottom (width reduction)



Naïve algorithm

- Check all possible paths
 - foolish and infeasible



Dynamic programming

1	4	3	5	2
3	2	5	2	3
5	2	4	2	1
1	7	3	9	4

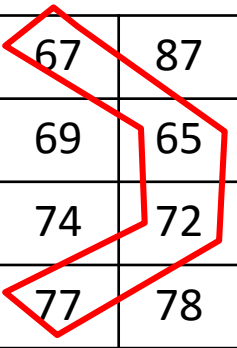
Importance image (M)

1	4	3	5	2
4	3	8	4	5
8	5	7	6	5
6	12	8	14	9

Cost matrix (C)

$$C(i, j) = M(i, j) + \min \begin{cases} C(i-1, j-1) \\ C(i-1, j) \\ C(i-1, j+1) \end{cases}$$

Deleting a column



67	87	255	88	24
69	65	59	221	23
74	72	70	222	190
77	78	90	94	49

Example cost matrix

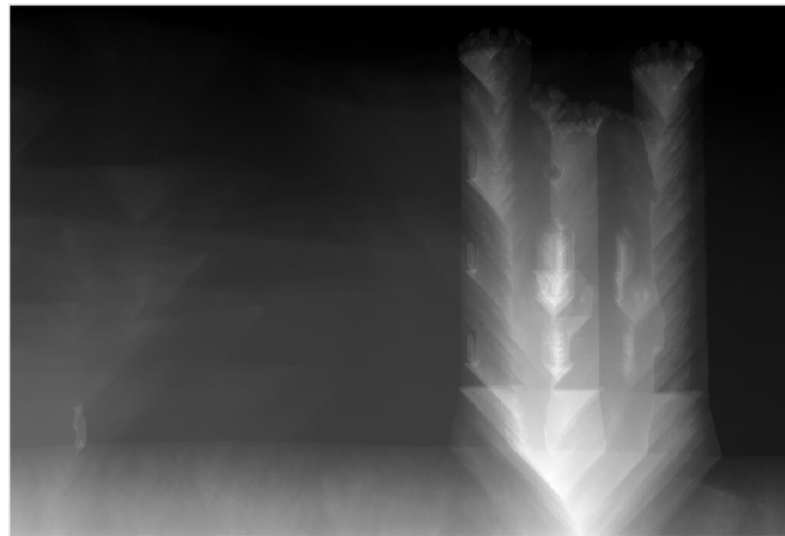
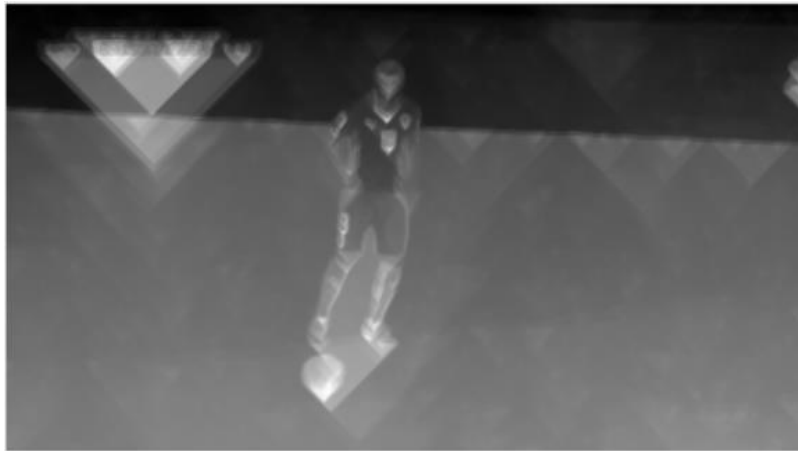
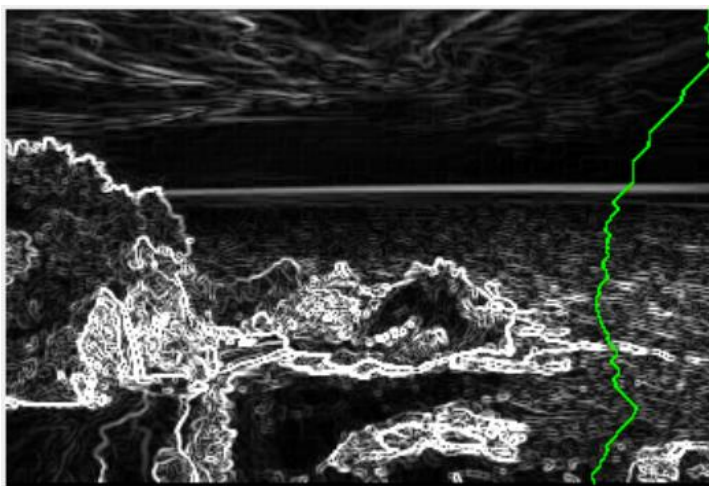


Image resizing: content aware

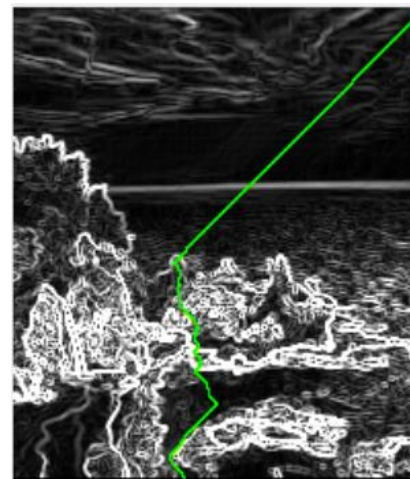




First
seam



Last
seam

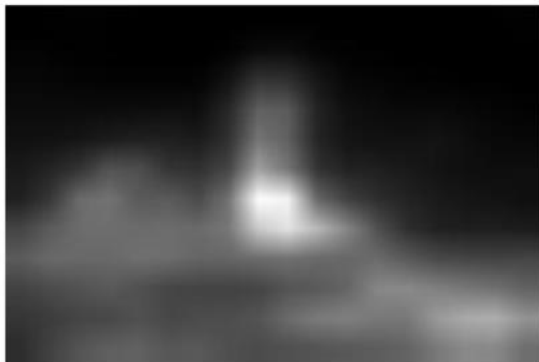


Changing the importance criteria

**Gradient
magnitude**



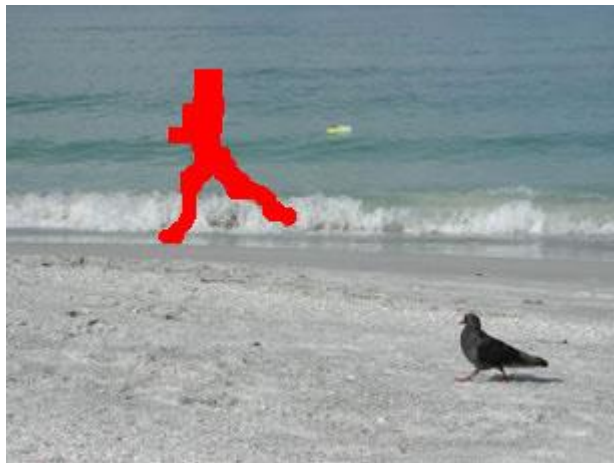
Saliency



Can we do more?



Can we do more?



Can we do more?

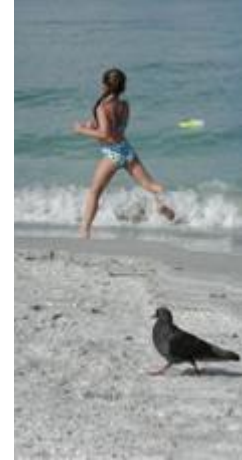


Image resizing: content aware



Failure: regular structures

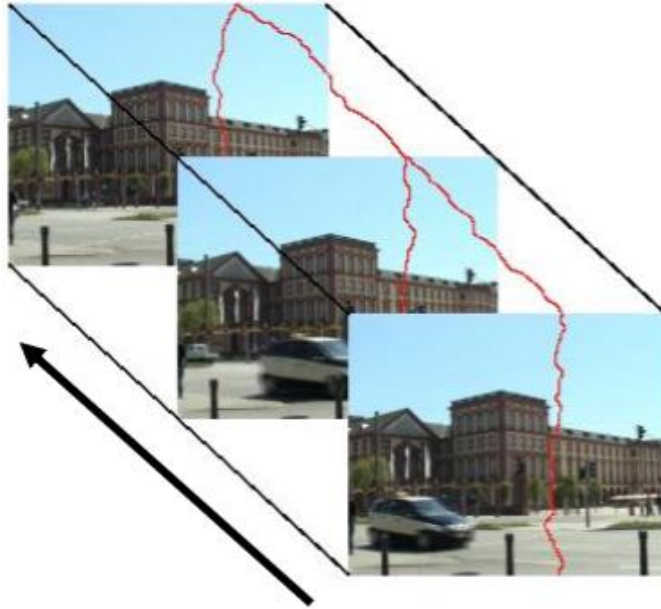


Failure: regular structures



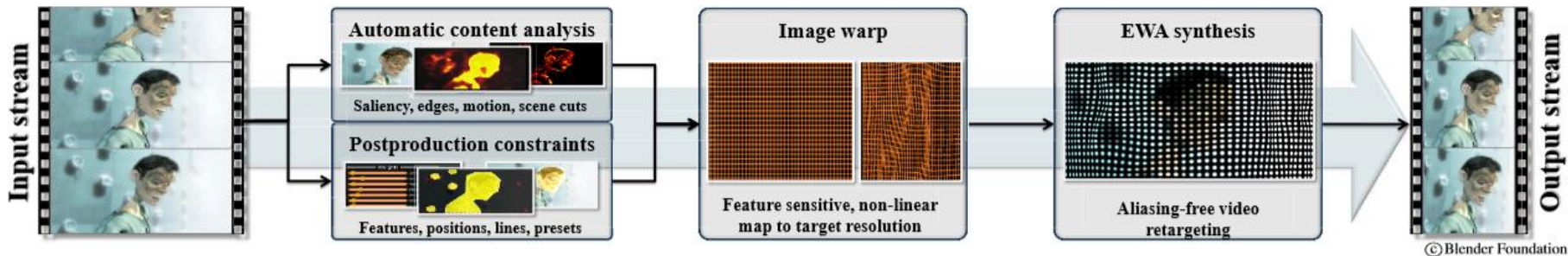
Seam carving for videos

- Also need to compensate for temporal coherency

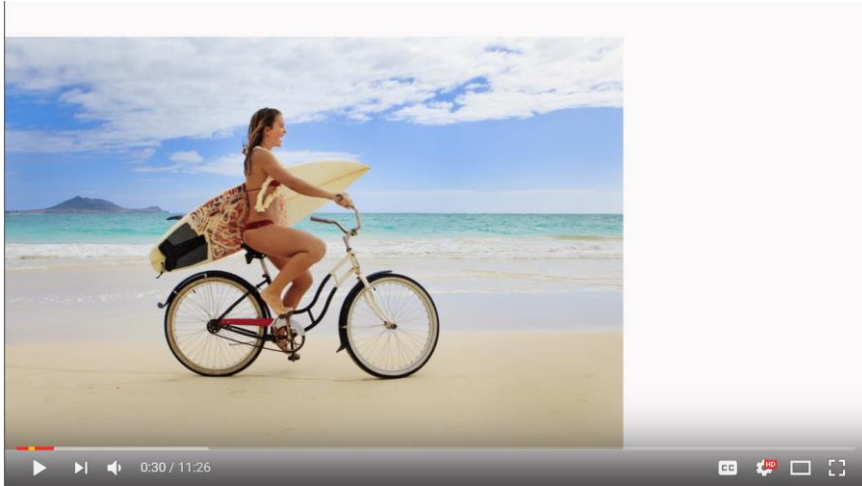


Other methods for content aware image resizing

- Shift map image editing (Pritch et al. ICCV 2009)
- Patch match (Barnes et al. SIGGRAPH 2009)
- Content aware warping (Krahenbuhl et al. SIGGRAPH ASIA 2009)
- A comparative study (Rubinstein et al. SIGGRAPH ASIA 2010)



More



Application to texture synthesis

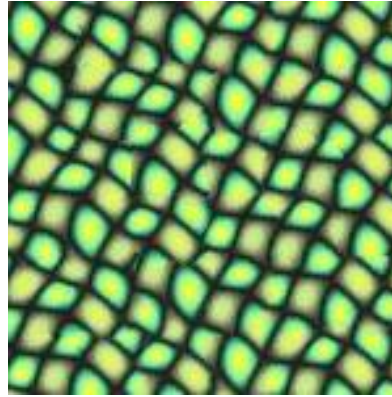
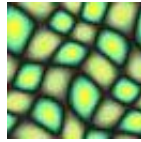
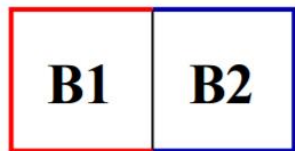
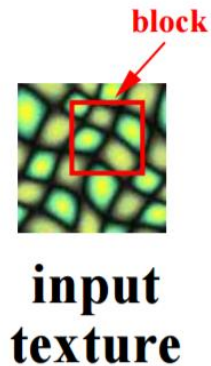
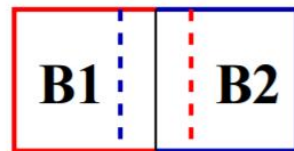
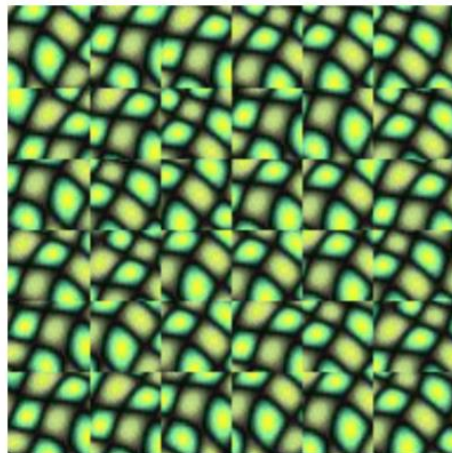


Image Quilting for Texture Synthesis & Transfer, SIGGRAPH 2001

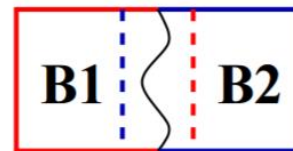
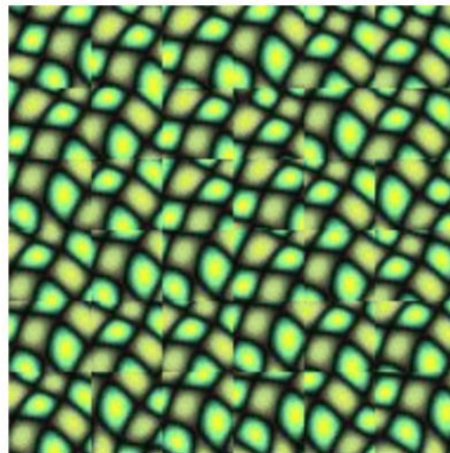
Application to texture synthesis



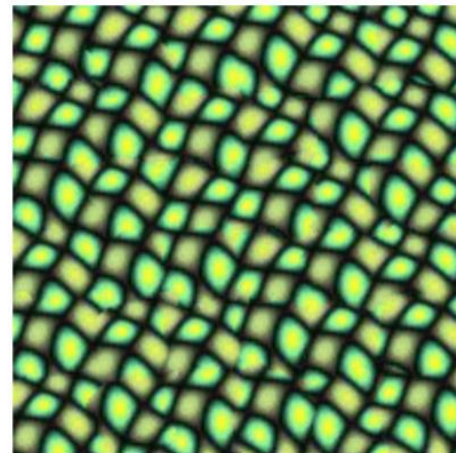
random placement
of blocks



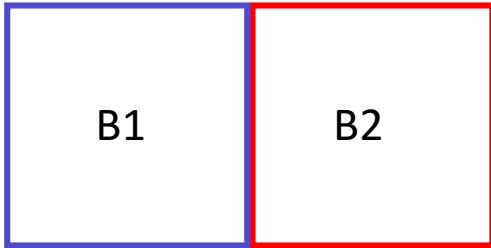
neighboring blocks
constrained by overlap



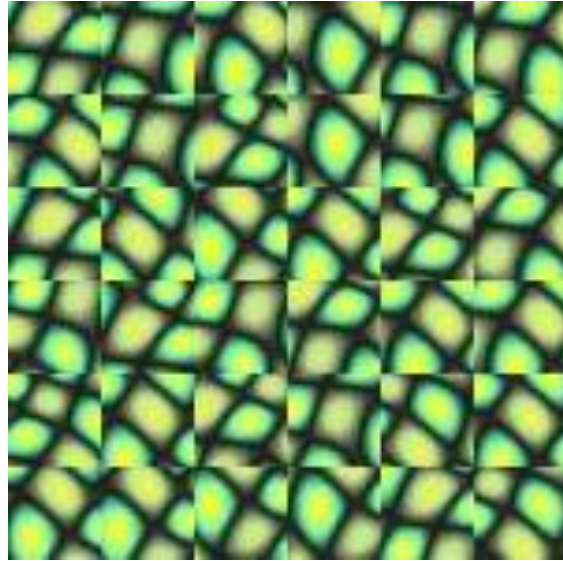
minimum error
boundary cut



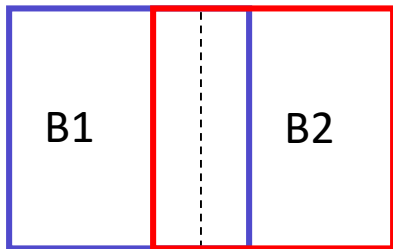
Application to texture synthesis



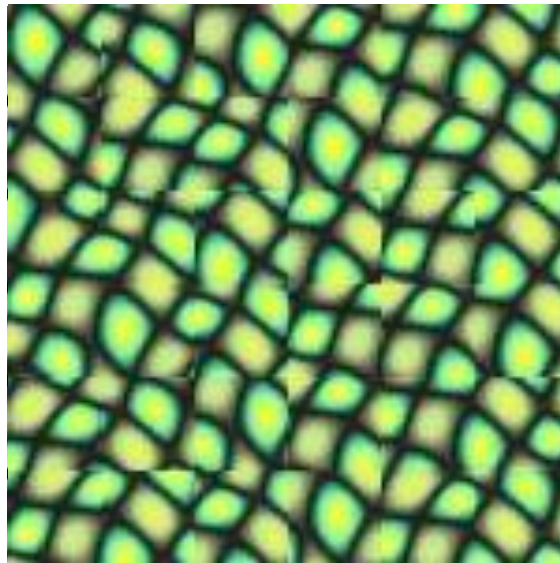
Random placement
of blocks



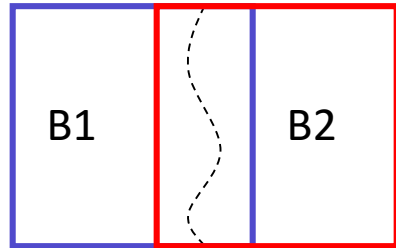
Application to texture synthesis



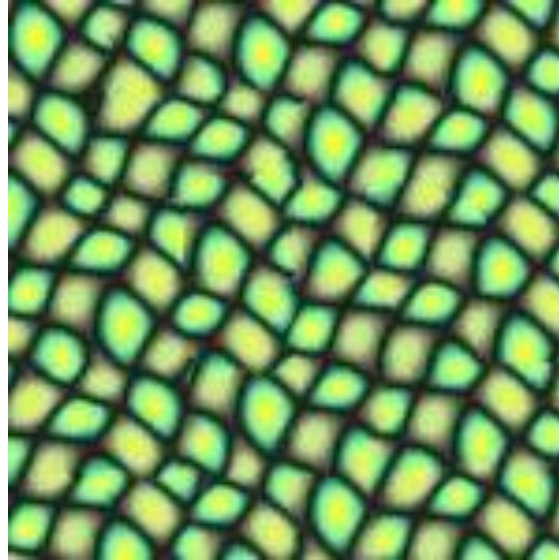
Neighboring blocks
constrained by overlap



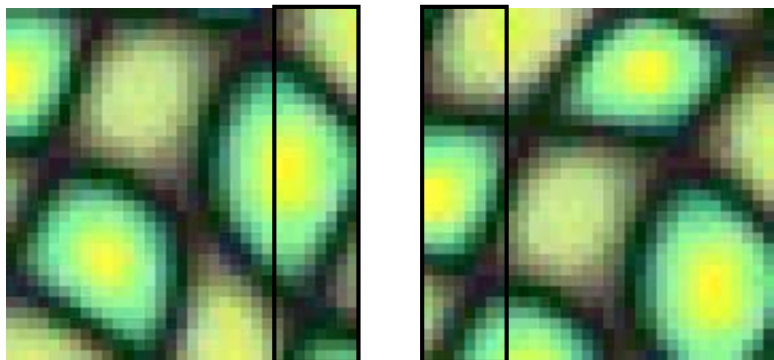
Application to texture synthesis



Minimal error
boundary cut



overlapping blocks



vertical boundary

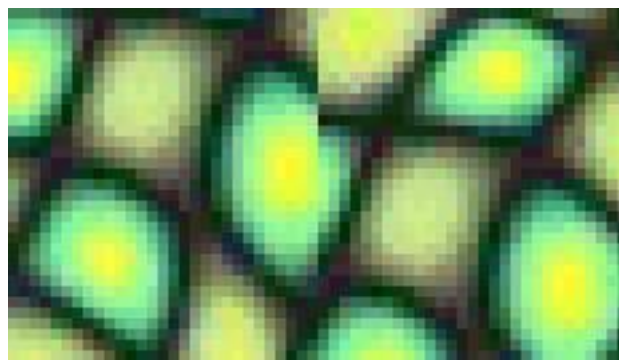
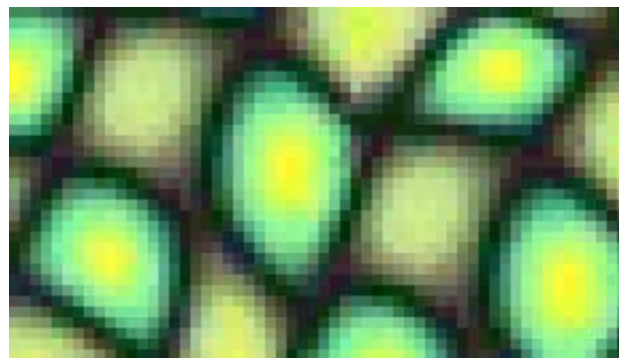


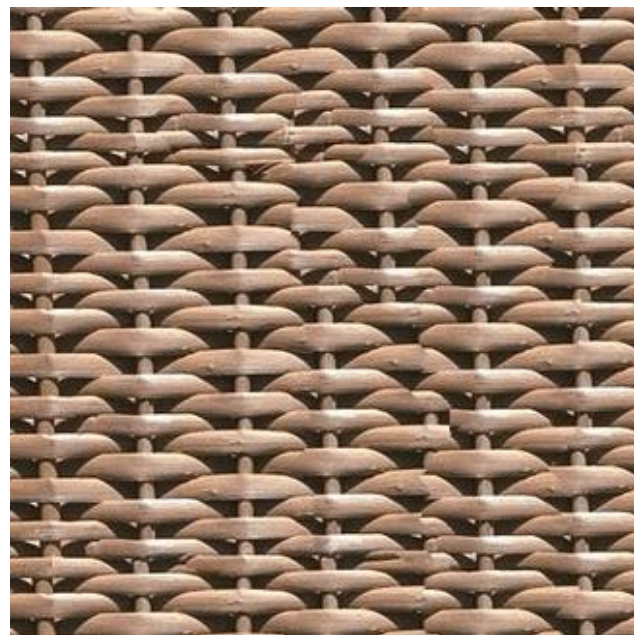
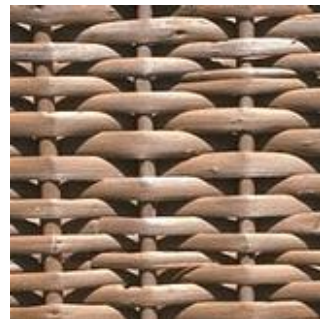
Diagram illustrating the calculation of overlap error. Two overlapping blocks are shown, with arrows pointing to their overlapping region. The equation is:

$$\left[\text{block}_1 - \text{block}_2 \right]^2 = \text{overlap error}$$

The result is a vertical strip showing the difference between the two blocks, with a red line indicating the boundary.



min. error boundary











+



rice

=



parmesan



+



=



