Artistic Stylization and Rendering

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Adobe Research

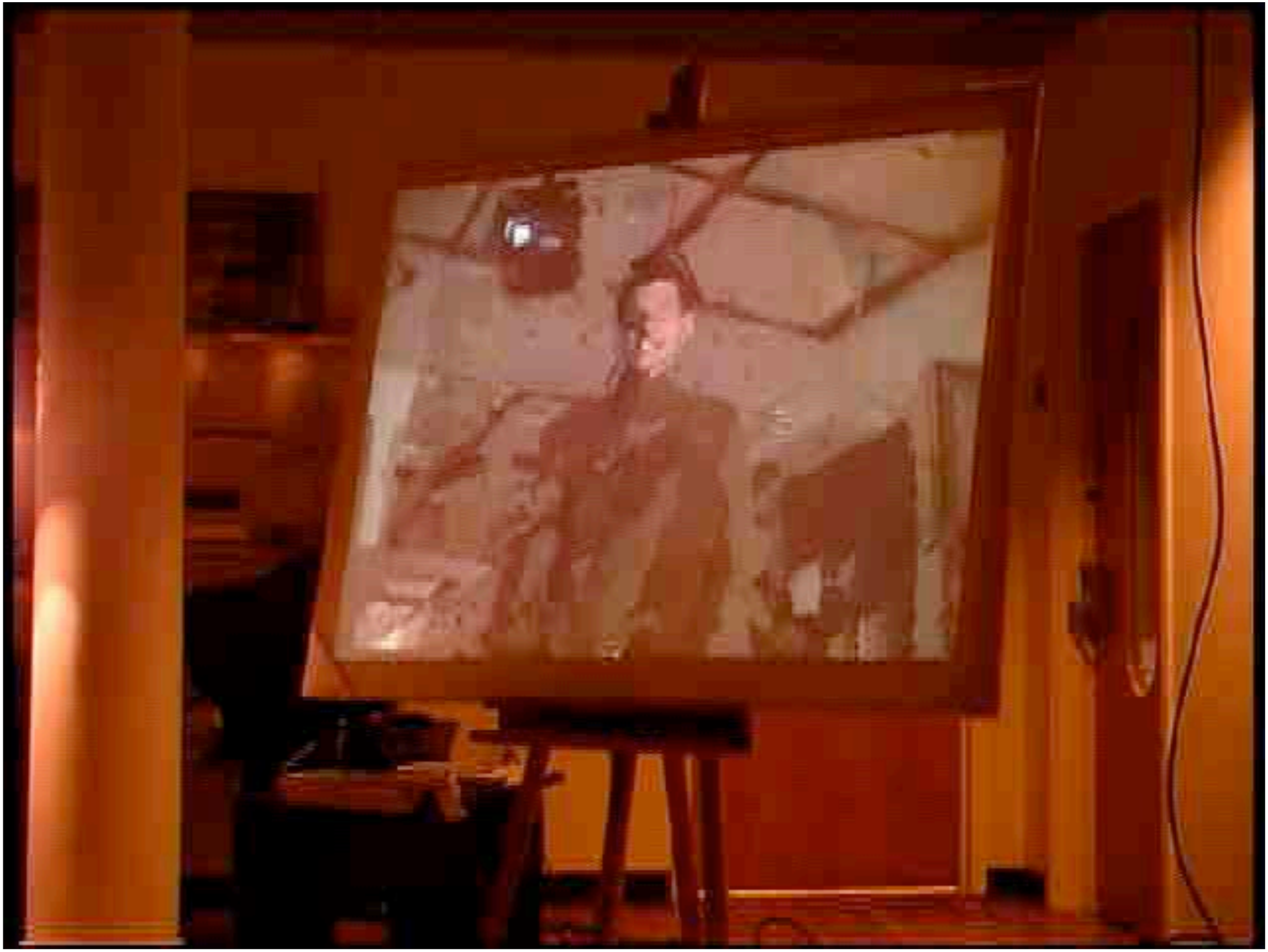
San Francisco

```
class Nullspace implements Constants, Cloneable
{
  /** The rows of the nullspace */
  Vector rows = new Vector();

  /** A list of the variables currently contained in the nullspace */
  Vector variables = new Vector();

  /** Add a constraint to the nullspace
   *
   *  @param  c  The new constraint
   *  @return  True if the new constraint is already consistent with the
   *           existing nullspace
   */

  boolean add(Constraint c)
    {
      // Convert the Constraint into a Row
      // do this first to combine equivalent angles; might zero
      Row newRow = new Row(c);

      // Check if c contains any variables that the nullspace doesn't
      // If so, add them
      for(int i=0;i<newRow.sources.size();i++)
        {
          Object src = newRow.sources.elementAt(i);

          if (src instanceof AngleMeasure)
            src = ((AngleMeasure)src).getEquivalent();

          if (variables.indexOf(src) < 0)
            addVariable(src);
        }

int nk = rows.size();    // n-k = num vars - num constraints
int[] Nx = new int[nk];
boolean zero = true;

int pivot = -1;

// compute N * x, where N is the nullspace and x is the new row

for(int i=0;i<nk;i++)
  {
    Nx[i] = Row.dot((Row)rows.elementAt(i),newRow);
    if (Nx[i] != 0)
      {
        zero = false;
        pivot = i;
      }
  }

// test if the new constraint was already consistent

if (zero)
  return true;
```

Litwinowicz 1997

Input Image

Hertzmann, SIGGRAPH 1998



Hertzmann, NPAR 2000

Painted Camera

View More by This Developer

By Gilles DEZEUSTRE

Open iTunes to buy and download apps.

View in iTunes

$1.99

Category: Photo & Video
Updated: May 28, 2014
Version: 1.2
Size: 3.5 MB
Languages: English, Arabic, Catalan, Czech, Danish, Dutch, Finnish, French, German, Greek, Hebrew, Hungarian, Indonesian, Italian, Japanese, Korean, Malay, Norwegian Bokmål, Polish, Portuguese, Romanian, Russian, Simplified Chinese, Slovak, Spanish, Swedish, Thai, Traditional Chinese, Turkish, Ukrainian, Vietnamese
Seller: Gilles DEZEUSTRE
© 2013 The 11ers, LLC
Rated 4+

Description

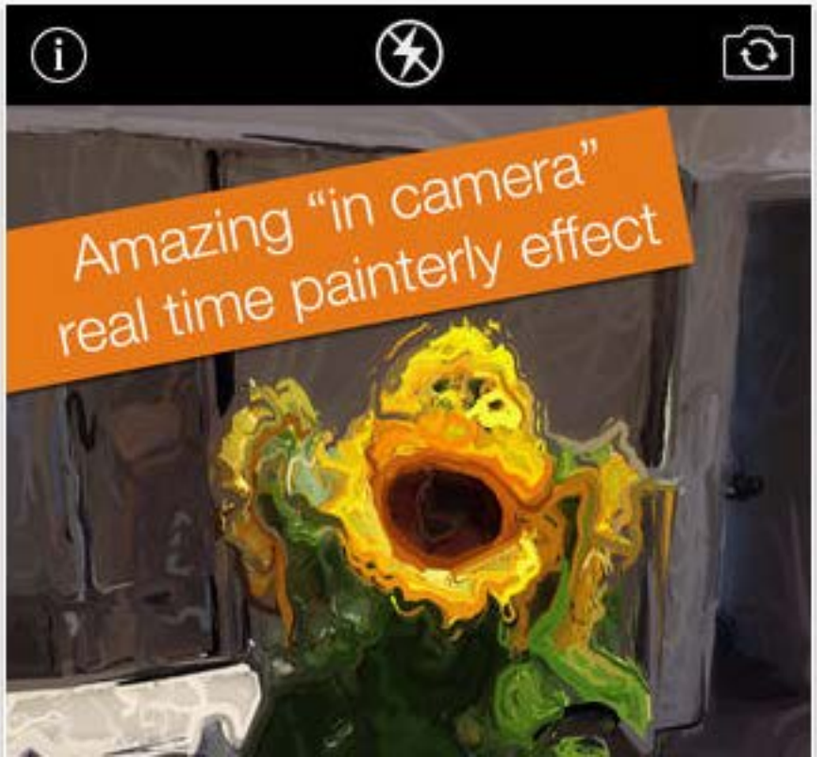
Painted Camera turns your iPhone and iPad into a magical lens that will show you the world through the eye of a painter. Capture beautiful images on the fly at a resolution high enough for gallery quality printing or record amazing painted videos with this unique app by The 11ers, the makers of Glaze, the cult painterly app for still

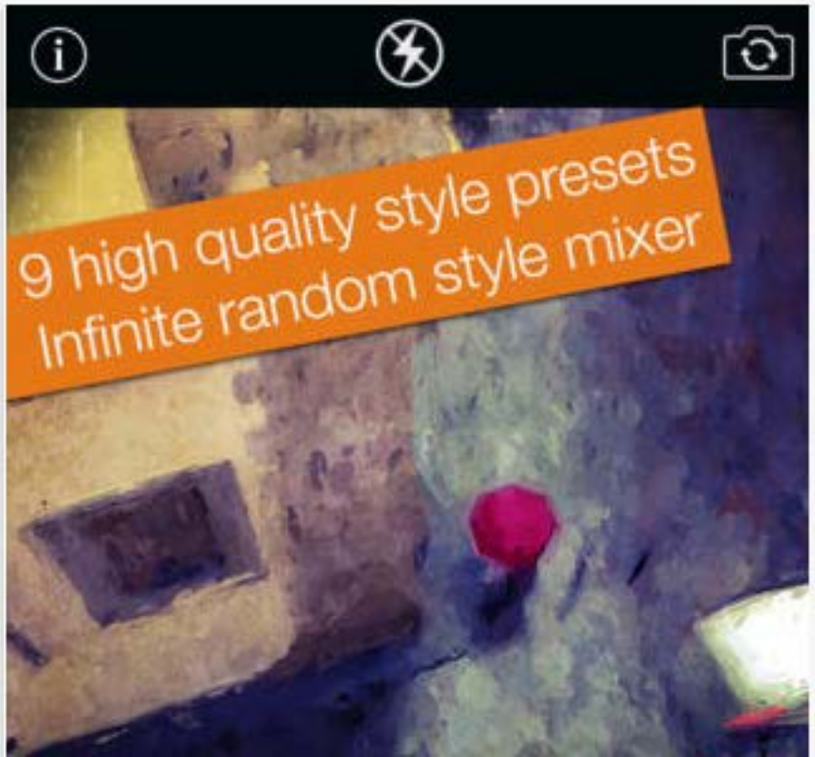
Gilles DEZEUSTRE Web Site ▸ Painted Camera Support ▸ ...More

What's New in Version 1.2

Updated App store screenshots.

iPhone Screenshots





Non-photorealistic rendering:
computer graphics and animation
inspired by natural artistic media

Research goals

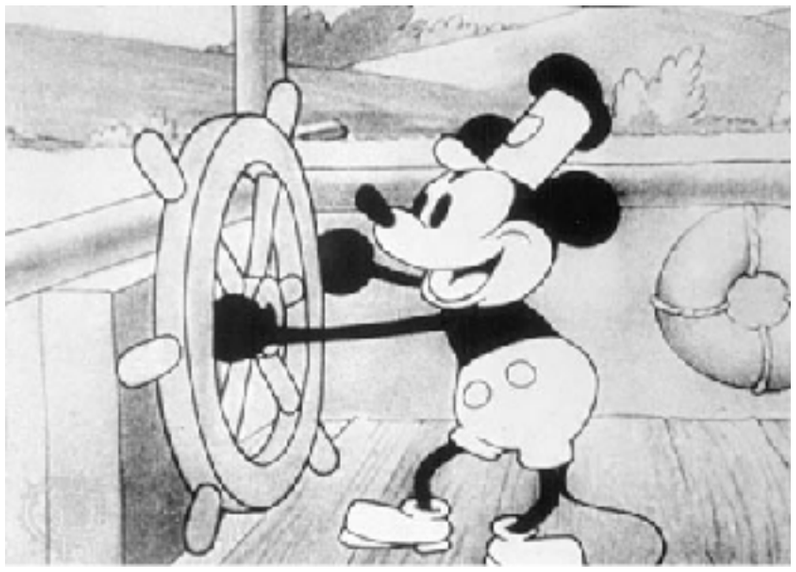
1. Scientific models for art

Research goals

2. Rendering algorithms

Research goals

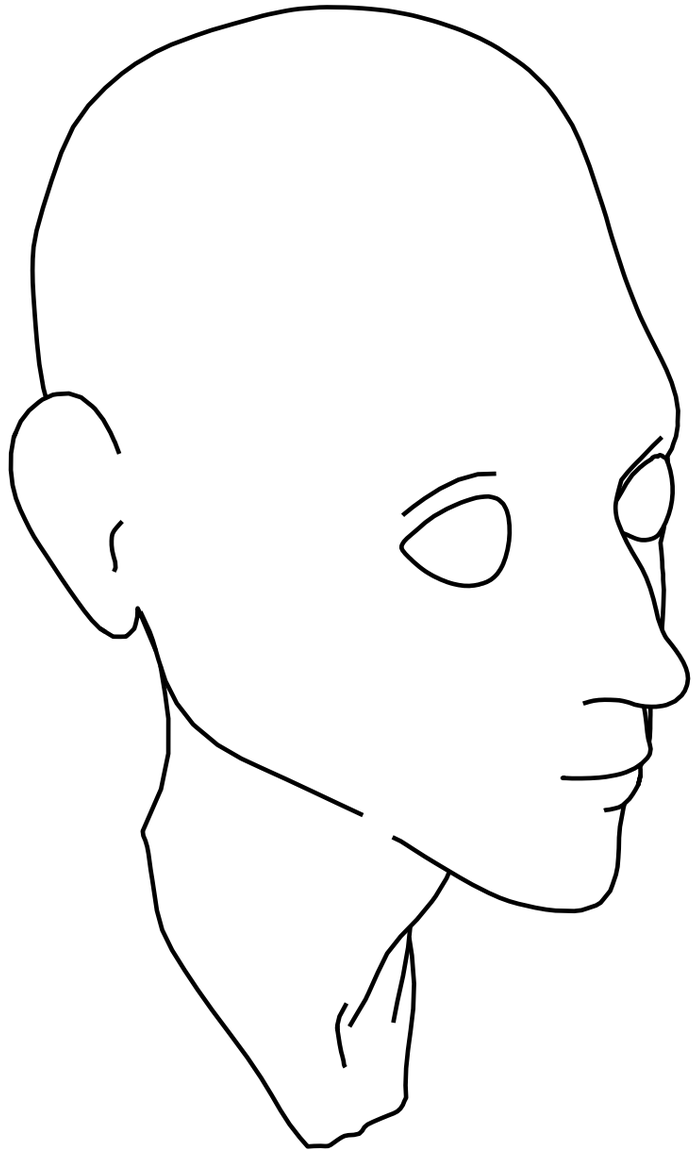
3. New artistic tools



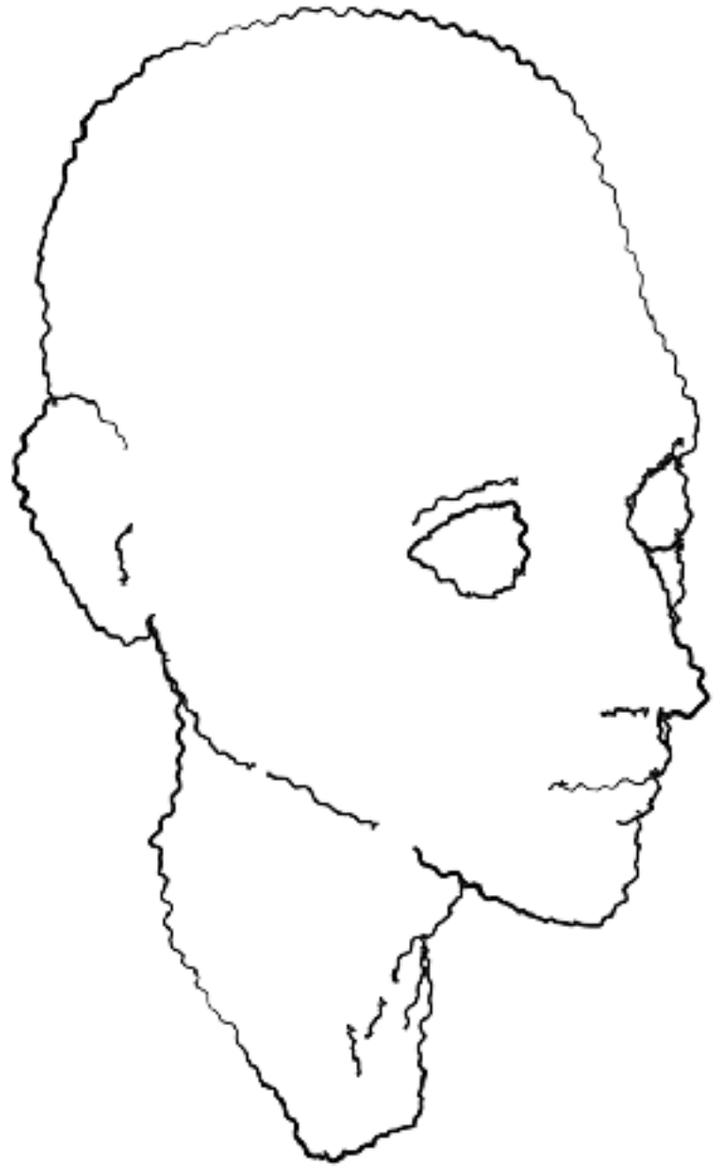
The development of art and technology have always gone hand-in-hand

3D Non-Photorealistic Rendering

Smooth surface

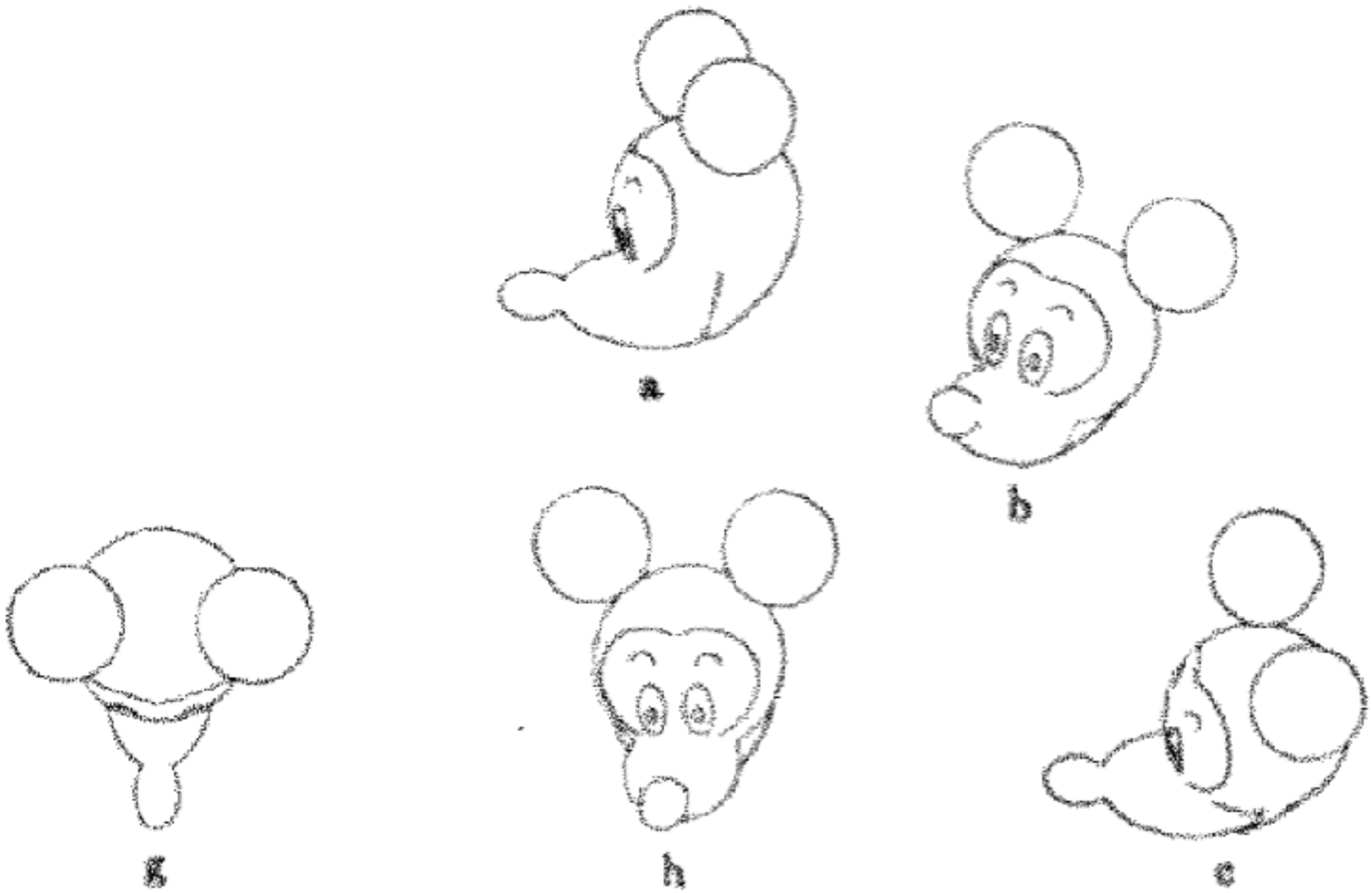


Occluding contours



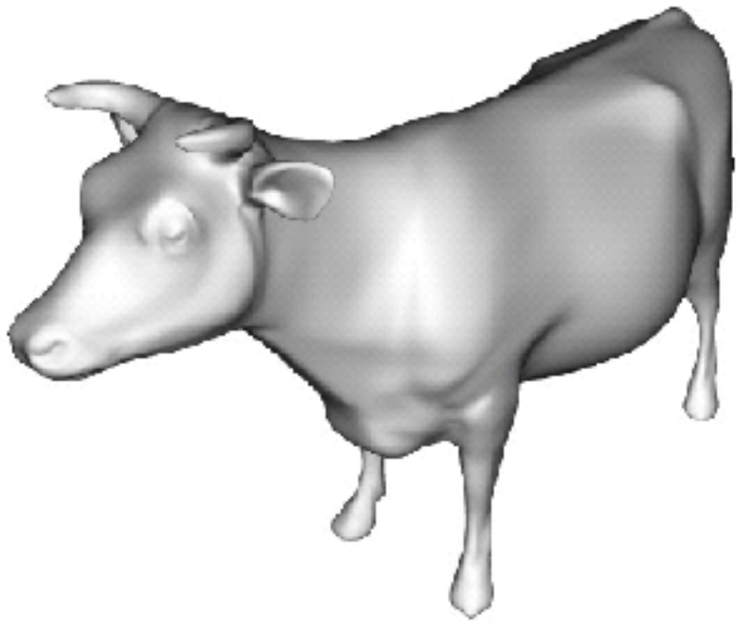
Stylized rendering

Occluding Contours

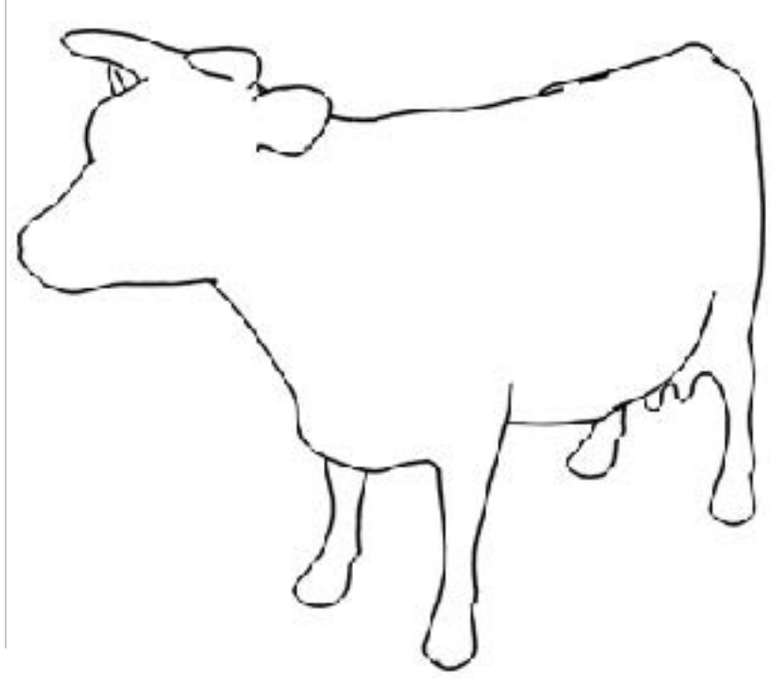


Weiss 1966

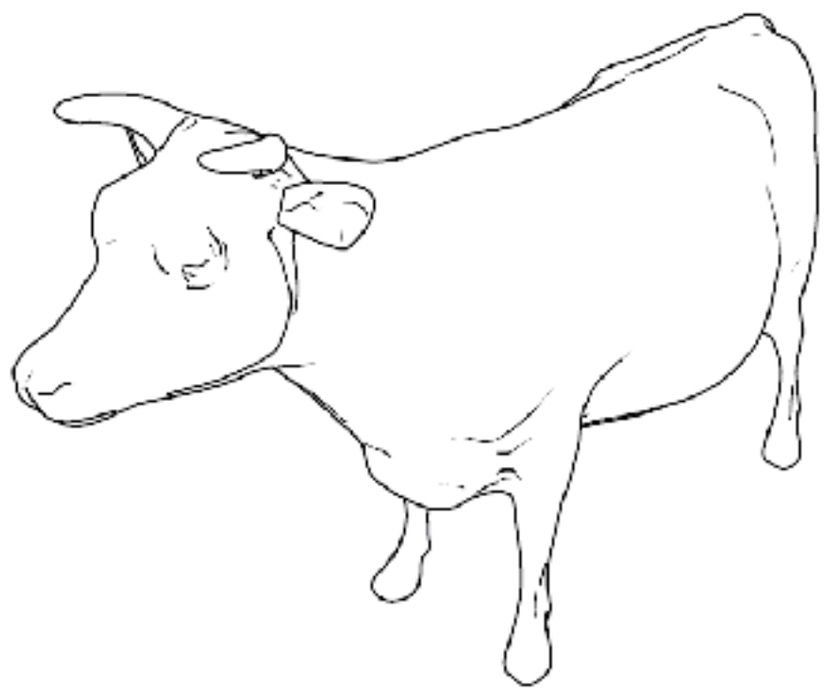
Suggestive Contours



Camera view



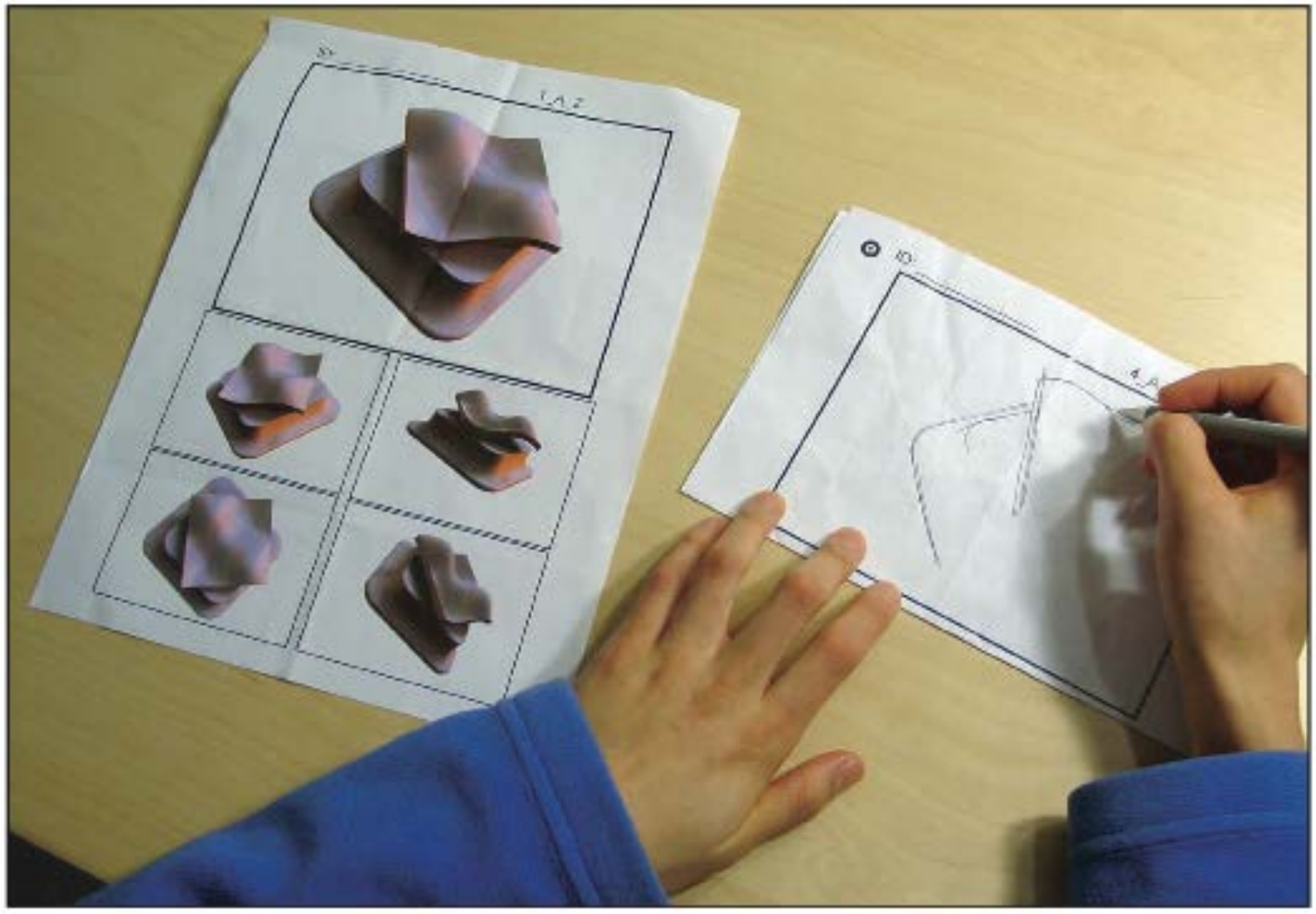
Contours



Contours+SC

DeCarlo et al. SIGGRAPH 2003

Studies on line drawing

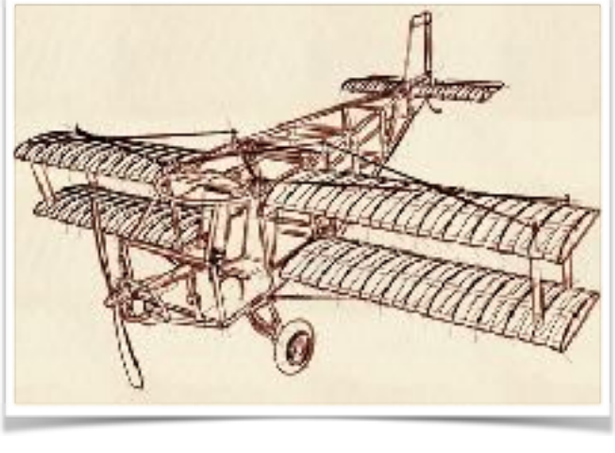


Cole et al. SIGGRAPH 2008

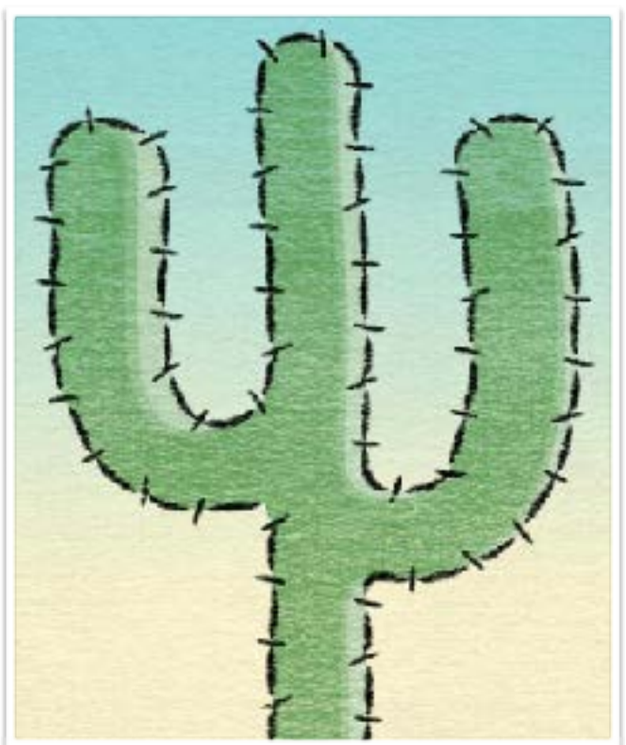
Stylized Contour Algorithms

[Eisemann et al. 2008]

[Buchholz et al. 2011]

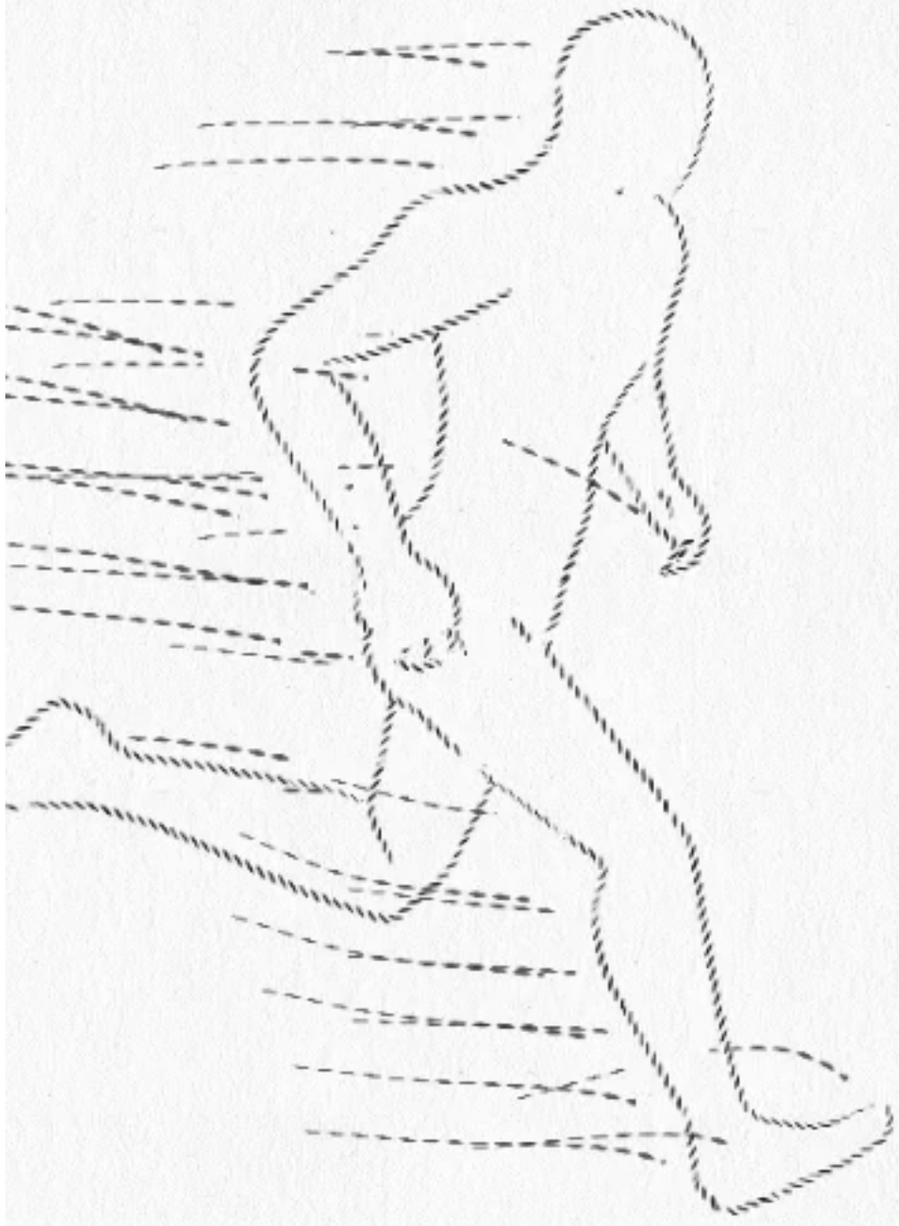


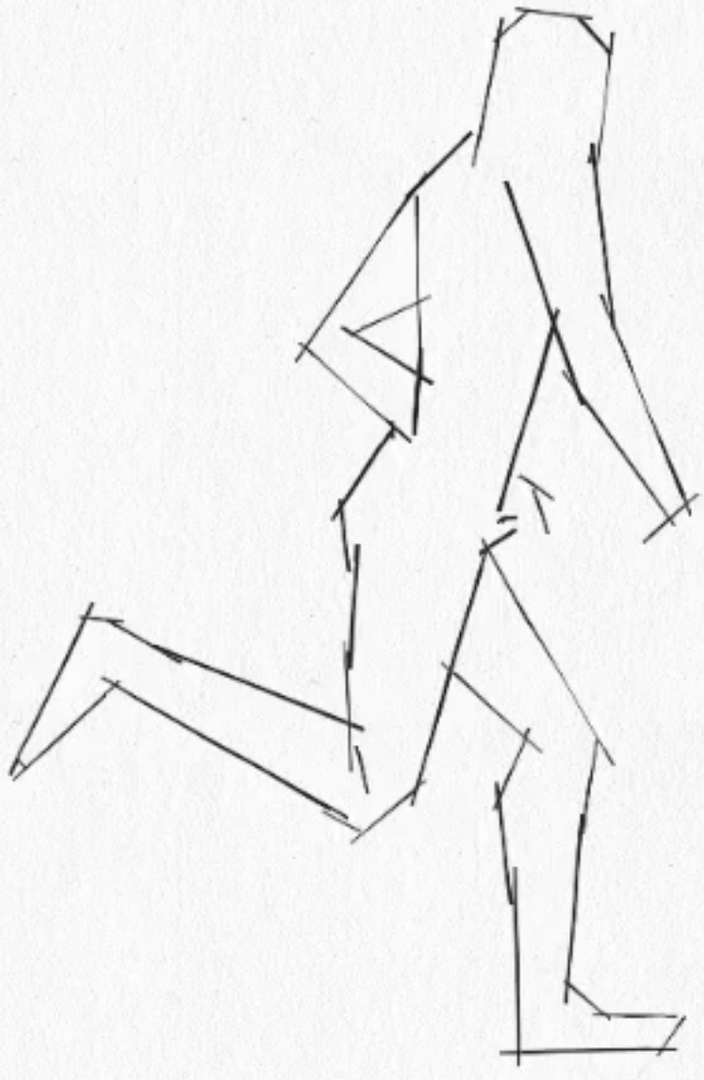
[Grabli et al. 2010]



[Kalnins et al. 2003]

[Hertzmann and Zorin 2000]





Bénard et al. NPAR 2012

Disney's Paperman

Procedural methods

Pro: lovely results,

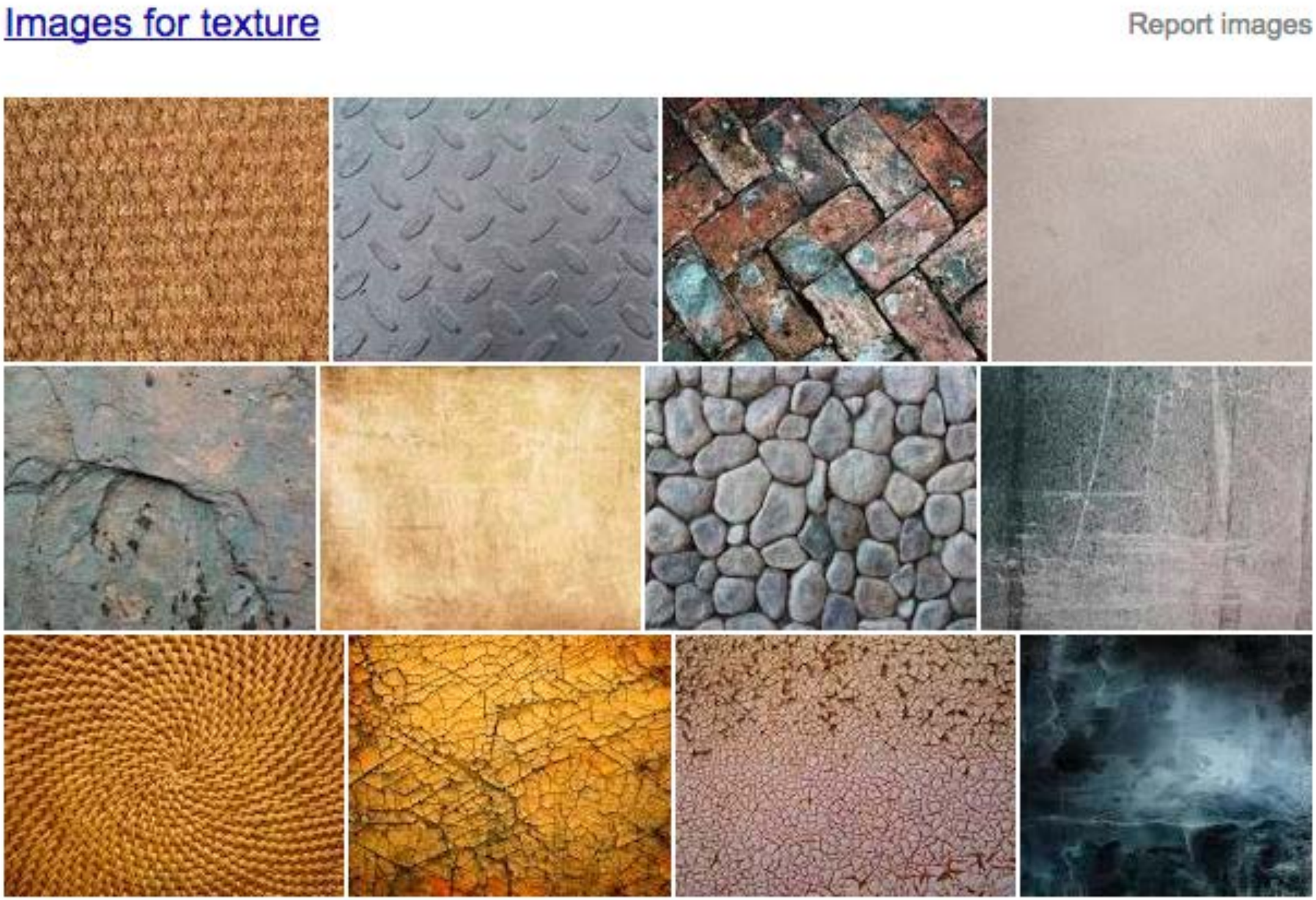
very controllable

Cons: hard to design styles,

complex to implement

What is texture?

What is texture?



Early Texture models

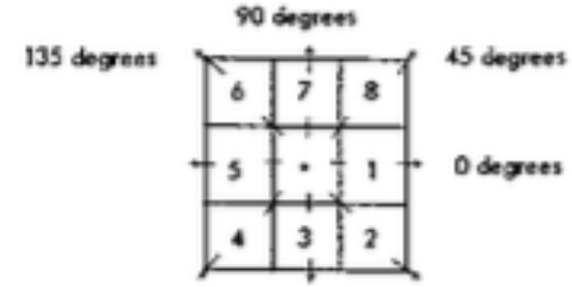


Fig. 1. Resolution cells 1 and 5 are 0° (horizontal) nearest neighbors to resolution cell •; resolution cells 2 and 6 are 135° nearest neighbors; resolution cells 3 and 7 are 90° nearest neighbors; and resolution cells 4 and 8 are 45° nearest neighbors to •. (Note this information is purely spatial, and has nothing to do with gray-tone values.)

Haralick 1973

Higher-Order Statistics

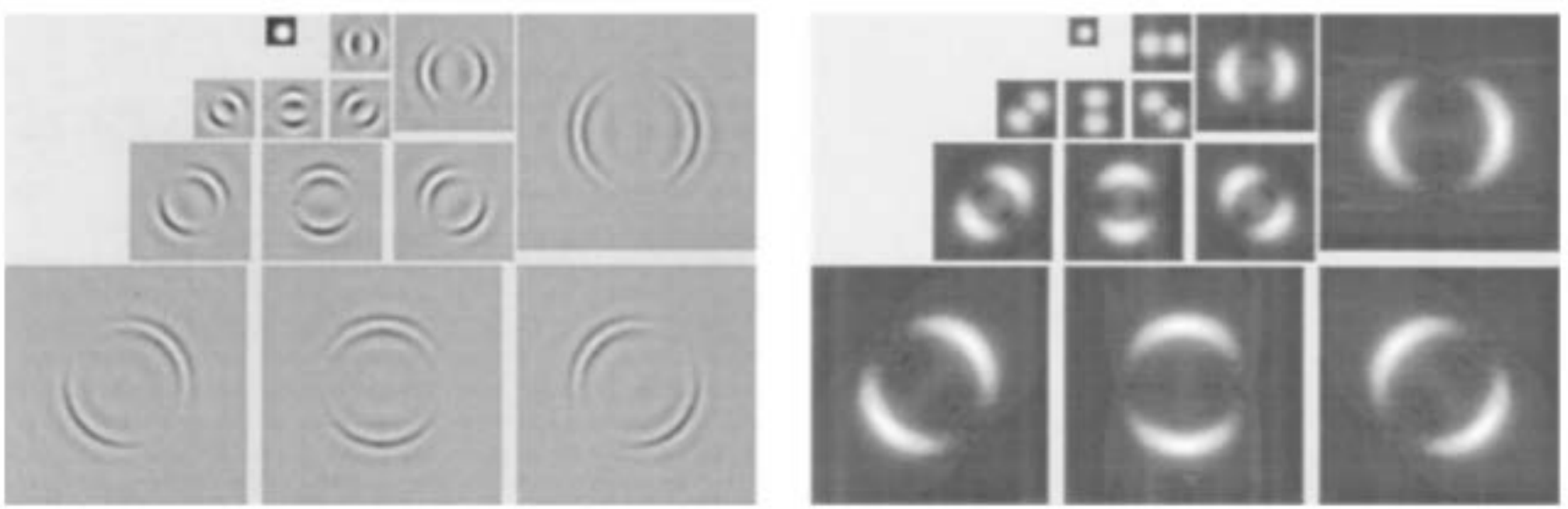


Figure 2. A 3-scale, 4-orientation complex steerable pyramid representation of a disk image. Left: real parts of oriented bandpass images at each scale and the final lowpass image. Right: magnitude (complex modulus) of the same subbands. Note that the highpass residual band is not shown.

Portilla and Simoncelli 2000

Higher-Order Statistics

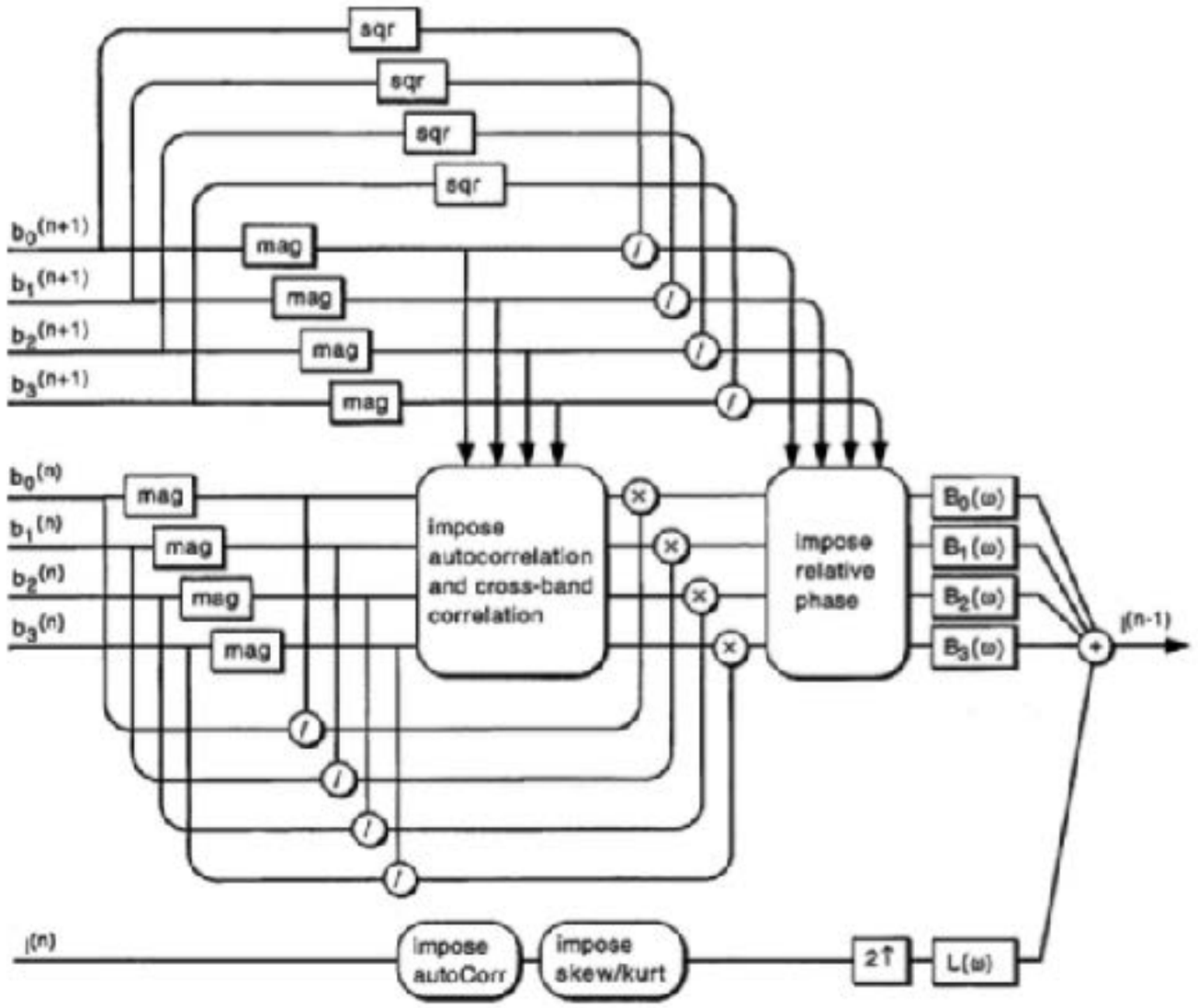


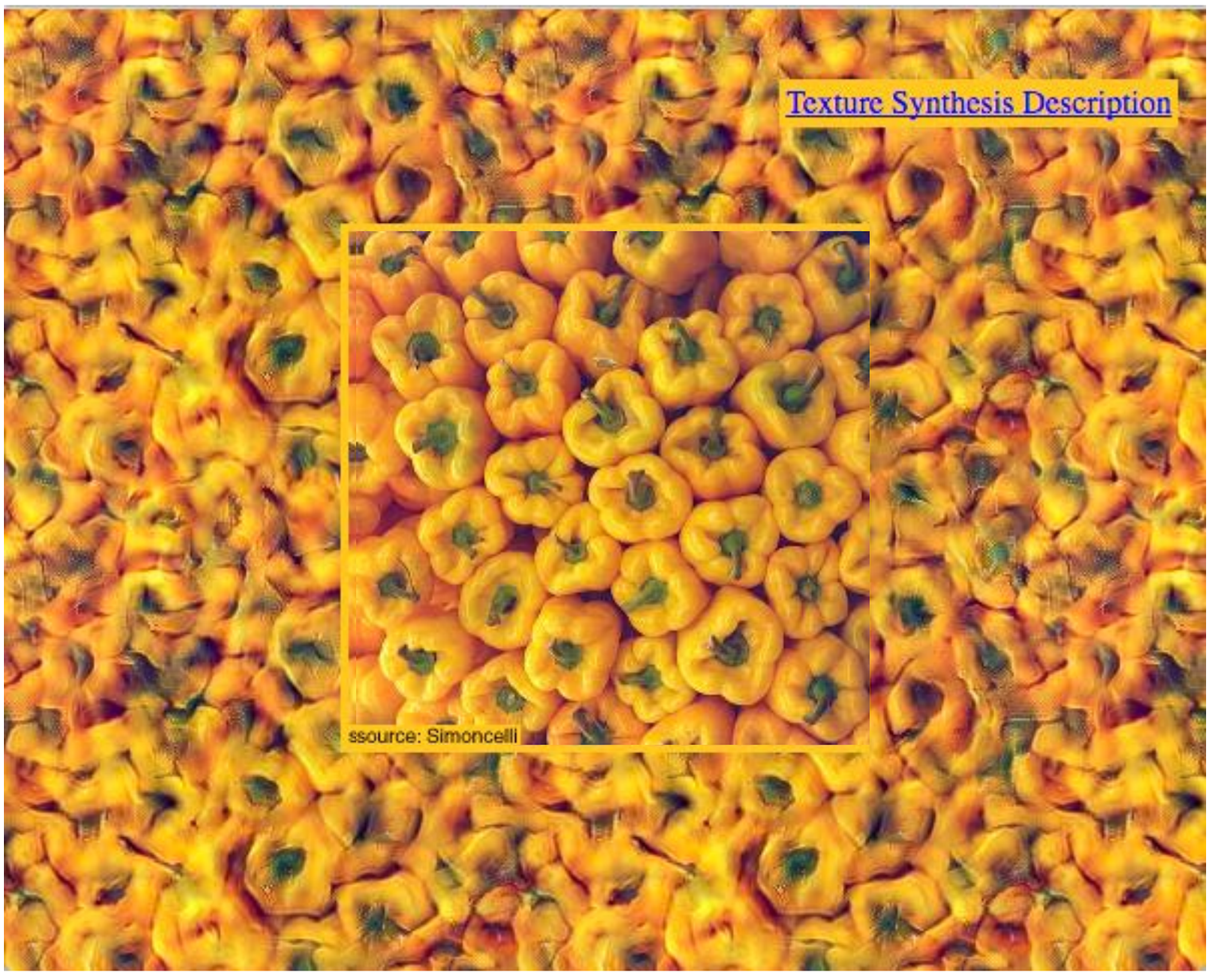
Figure 10. Block diagram describing the coarse-to-fine adjustment of subband statistics and reconstruction of intermediate scale lowpass image (gray box of Fig. 9).

Portilla and Simoncelli 2000

Higher-Order Statistics

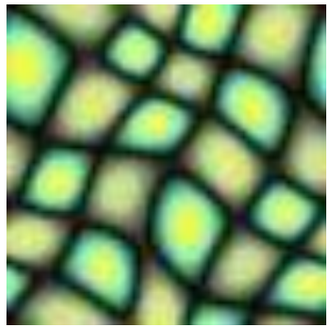
Portilla and Simoncelli 2000

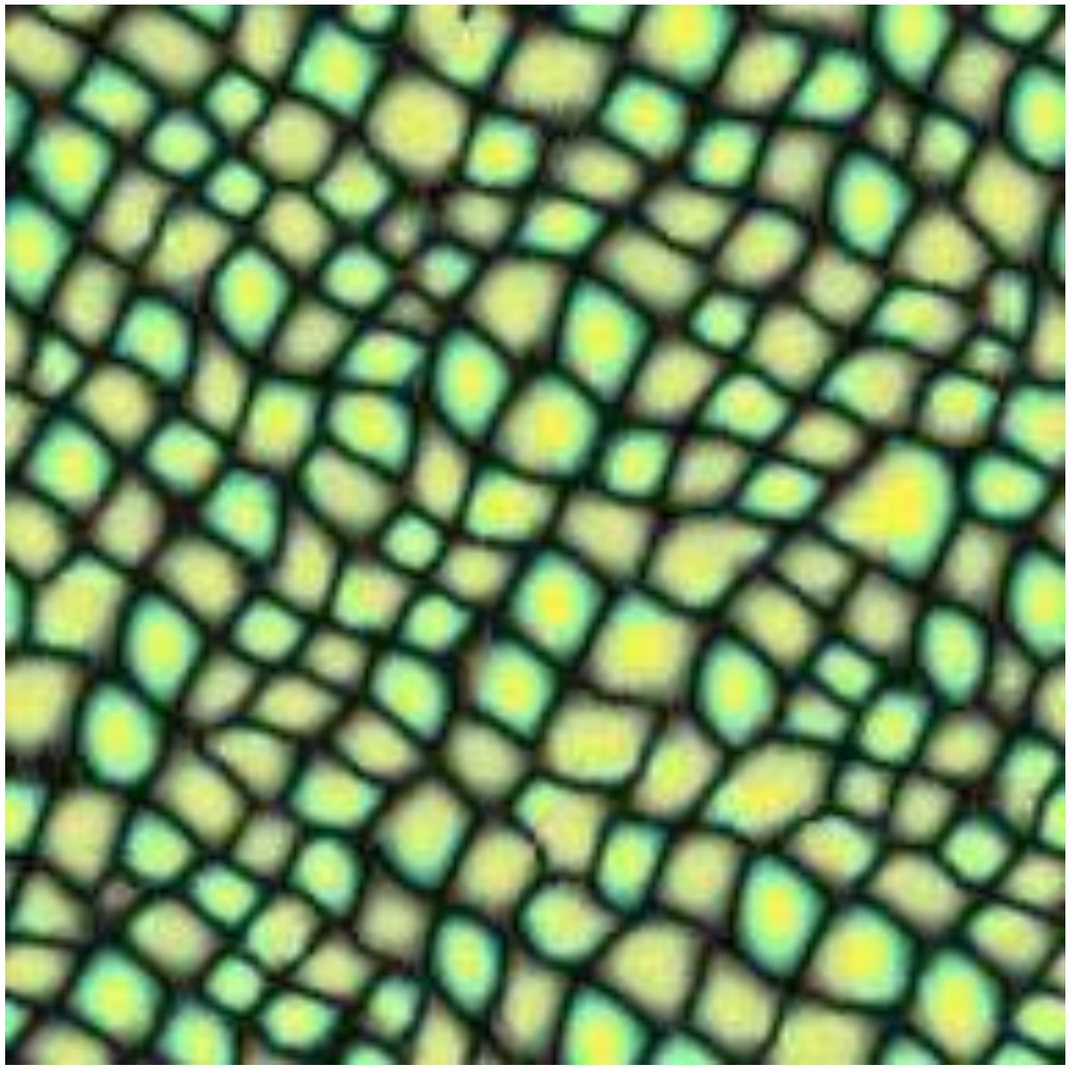
Higher-Order Statistics



Portilla and Simoncelli 1999

Patch-Based Texture



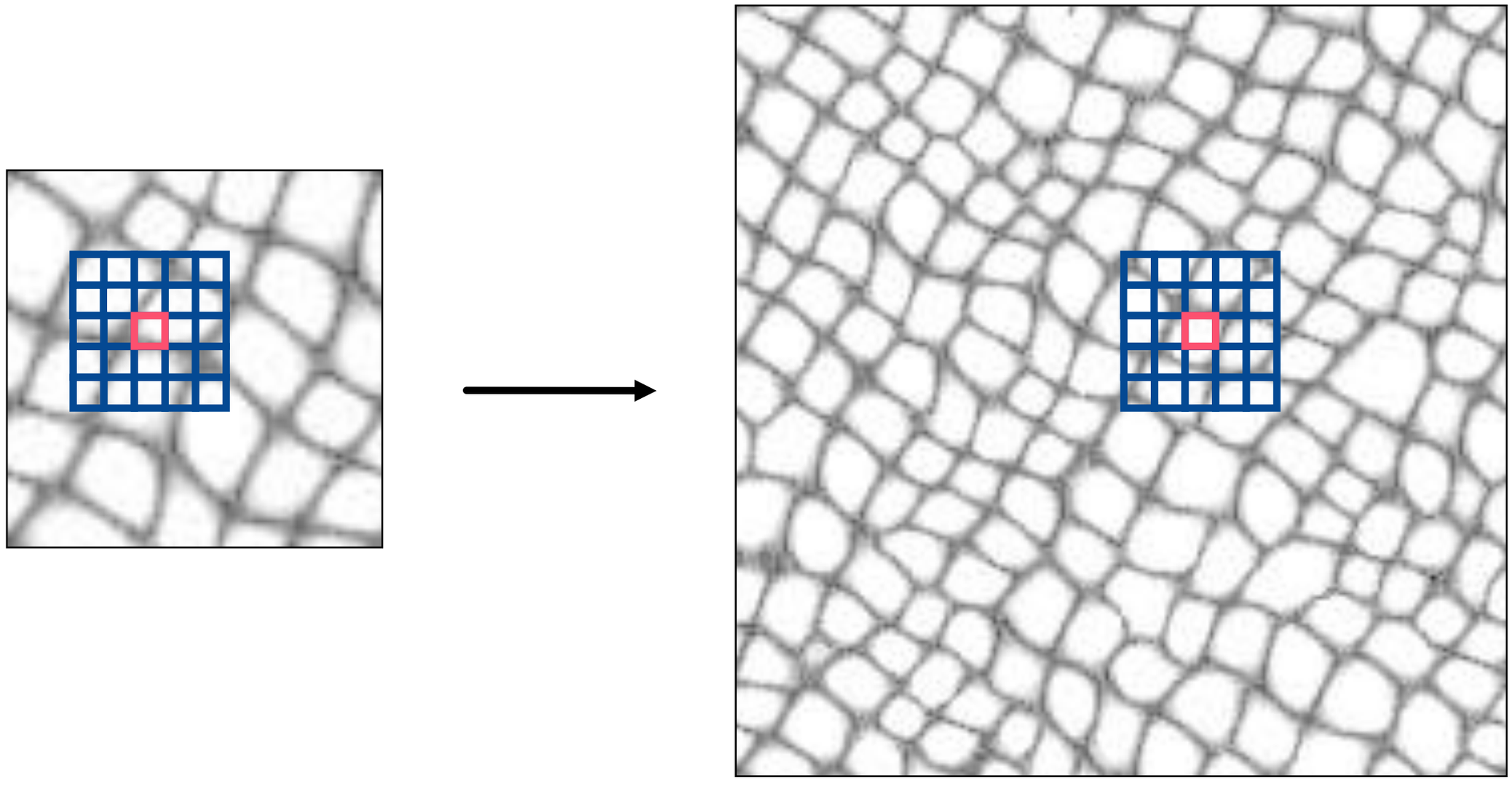


Input texture

Output texture

Efros and Leung 1999

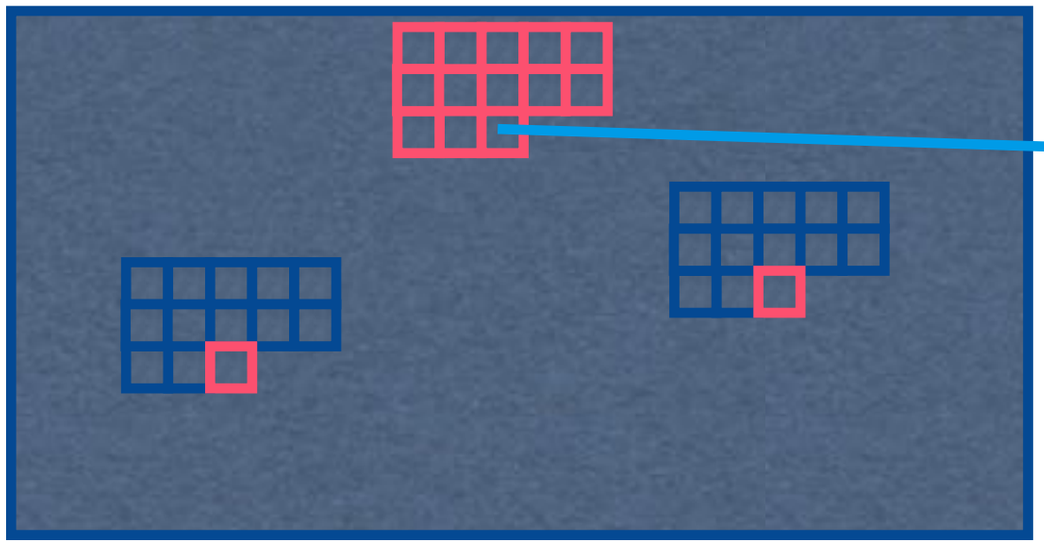
Patch-Based Texture



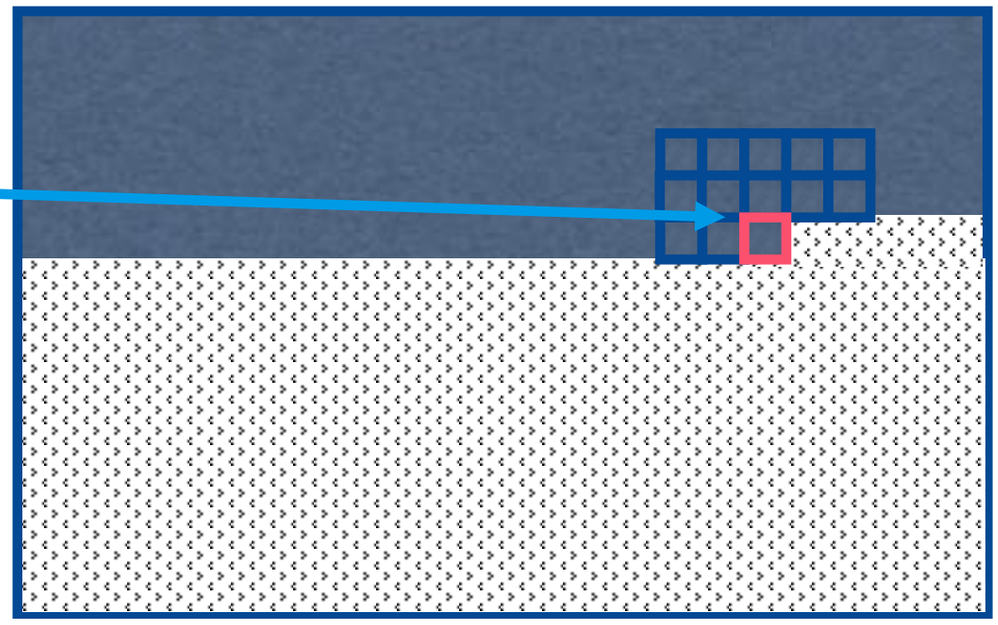
Input texture

Output texture

Efros and Leung 1999



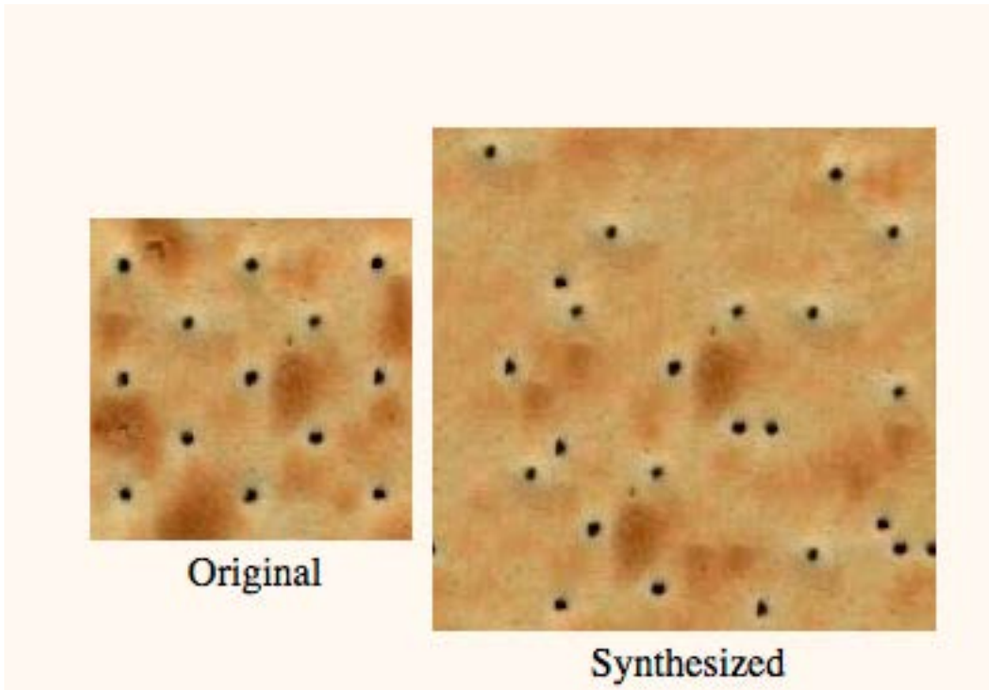
Input texture

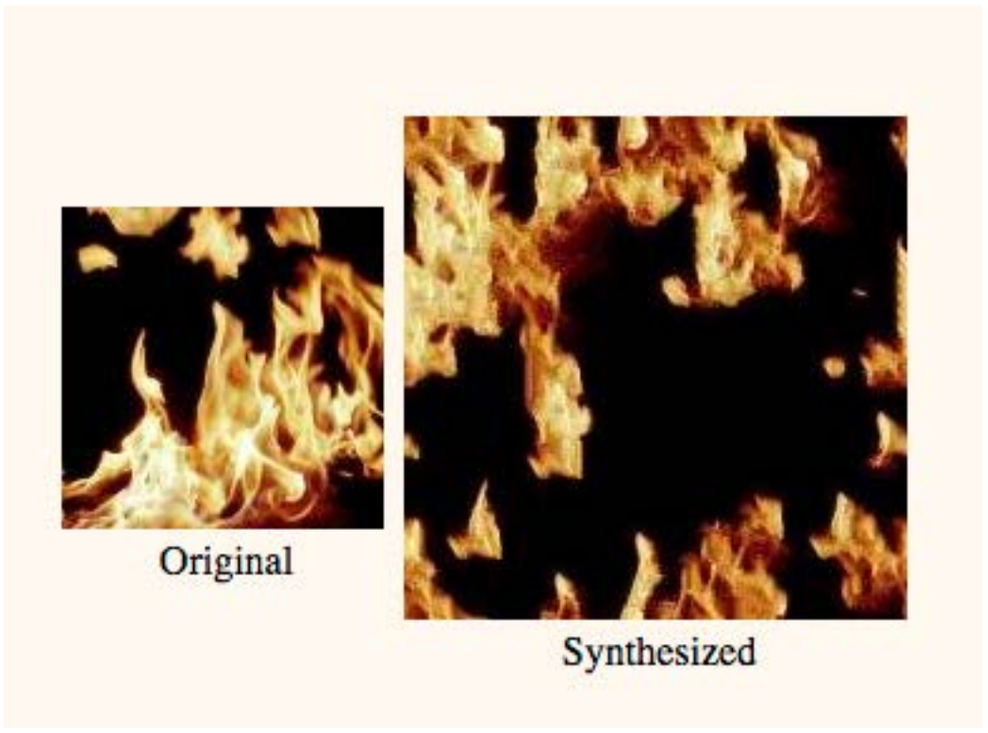


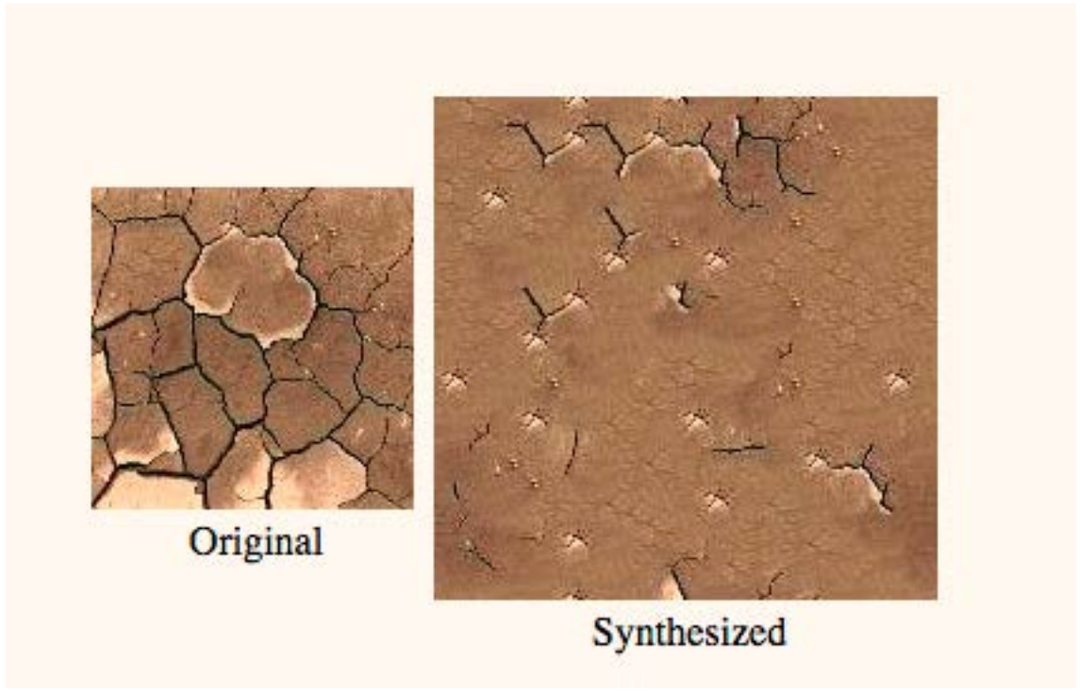
Output texture

Efros and Leung 1999, Wei and Levoy 2000

Results

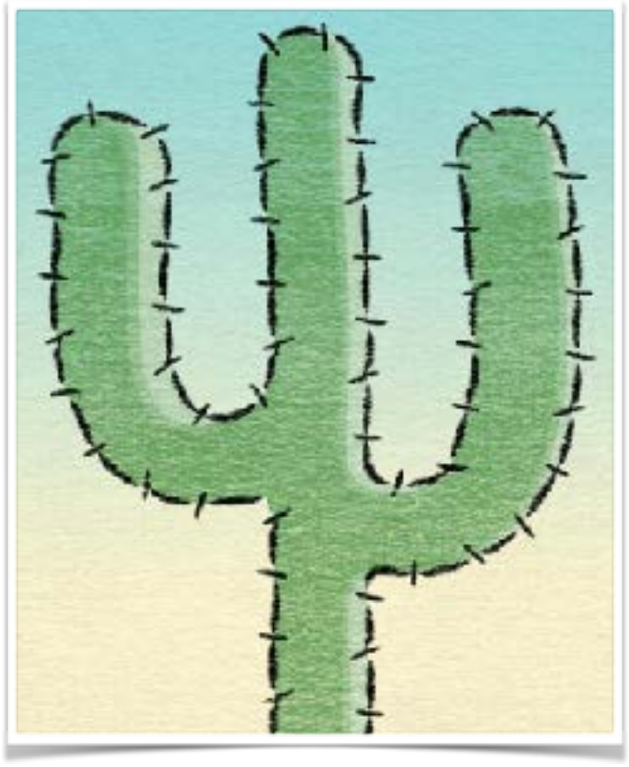






Efros and Leung 1999, Wei and Levoy 2000

Curve stylization



Curve Propagation

Frame 1

Frame 2

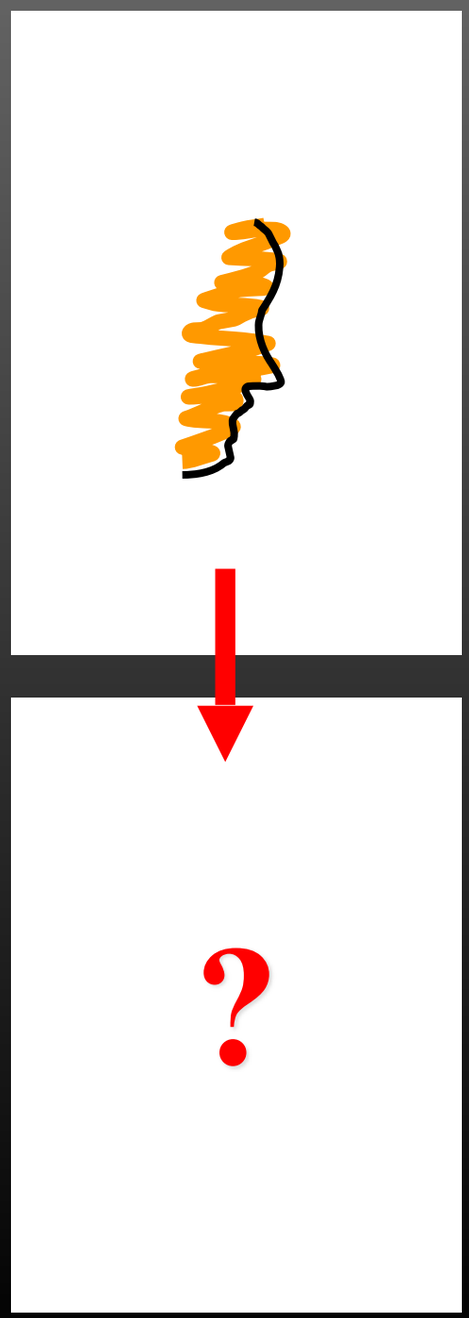
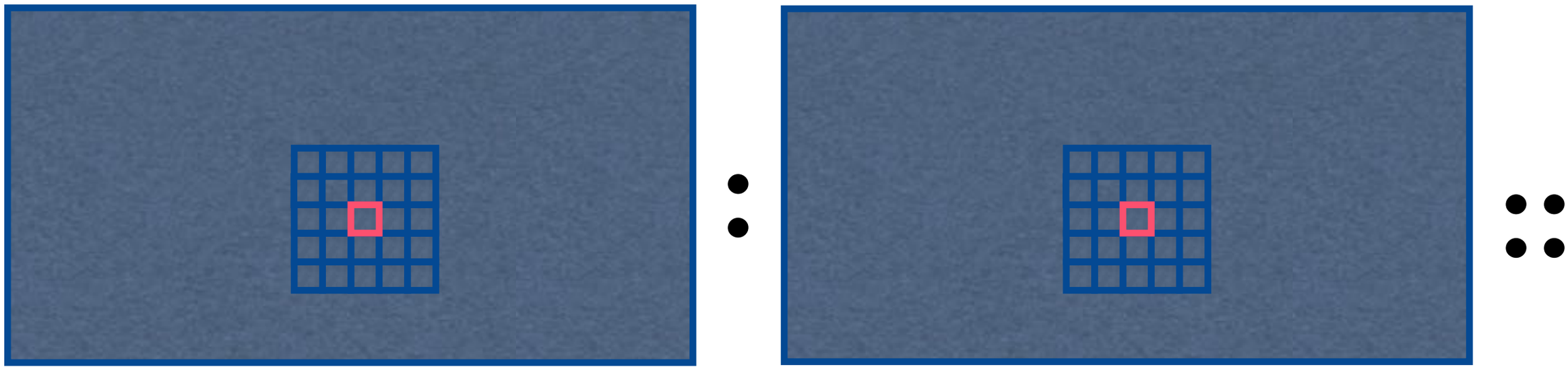


Image Analogies

Goal: Process an image by example

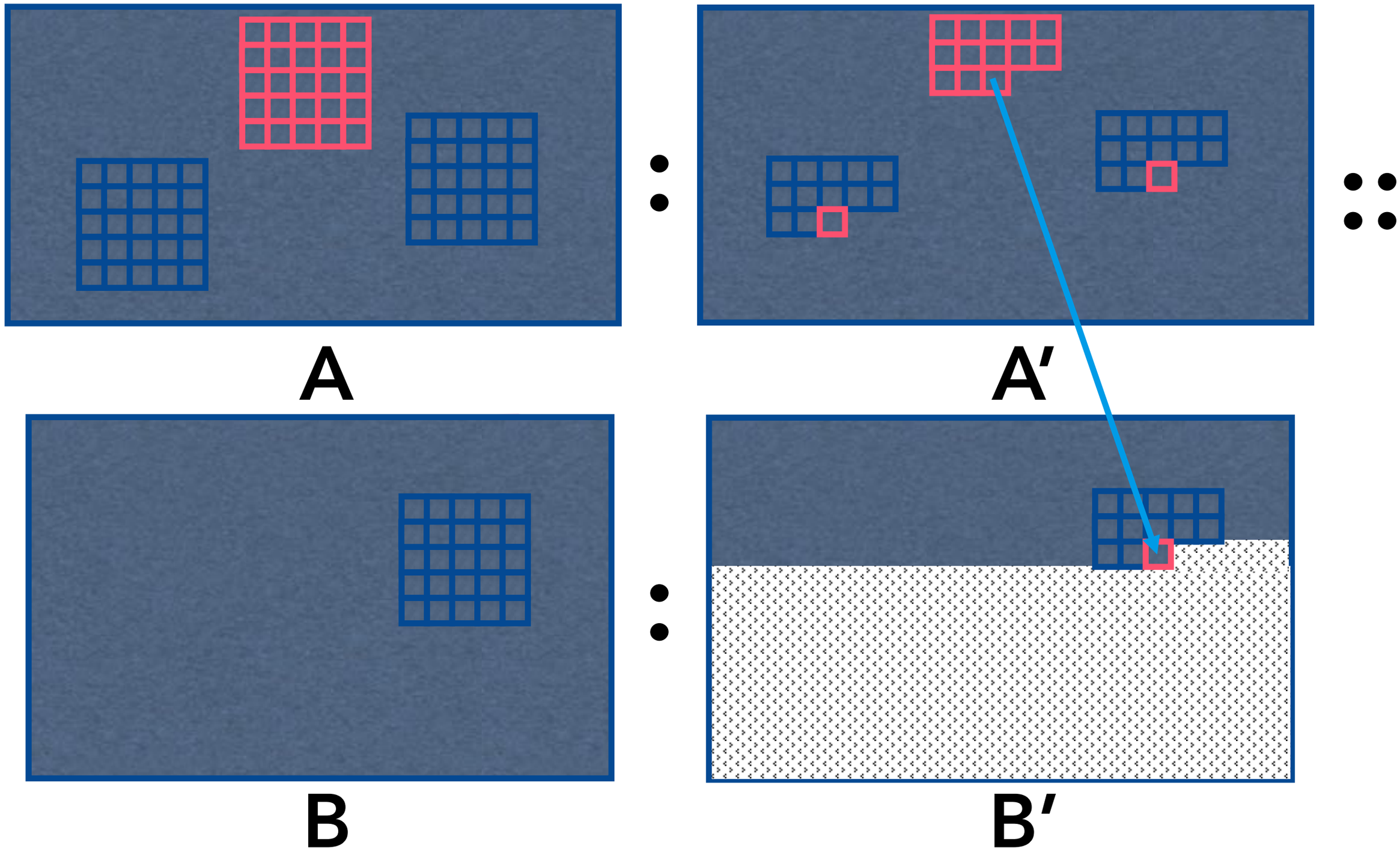
A : A′ :: B : B′

Hertzmann et al. SIGGRAPH 2001



A : A′ :: B : B′

Hertzmann et al. SIGGRAPH 2001



Hertzmann et al. SIGGRAPH 2001

Blur

A

A’

B

B’

Hertzmann et al. SIGGRAPH 2001

Superresolution

Hertzmann et al. SIGGRAPH 2001

Texture transfer

A

A’

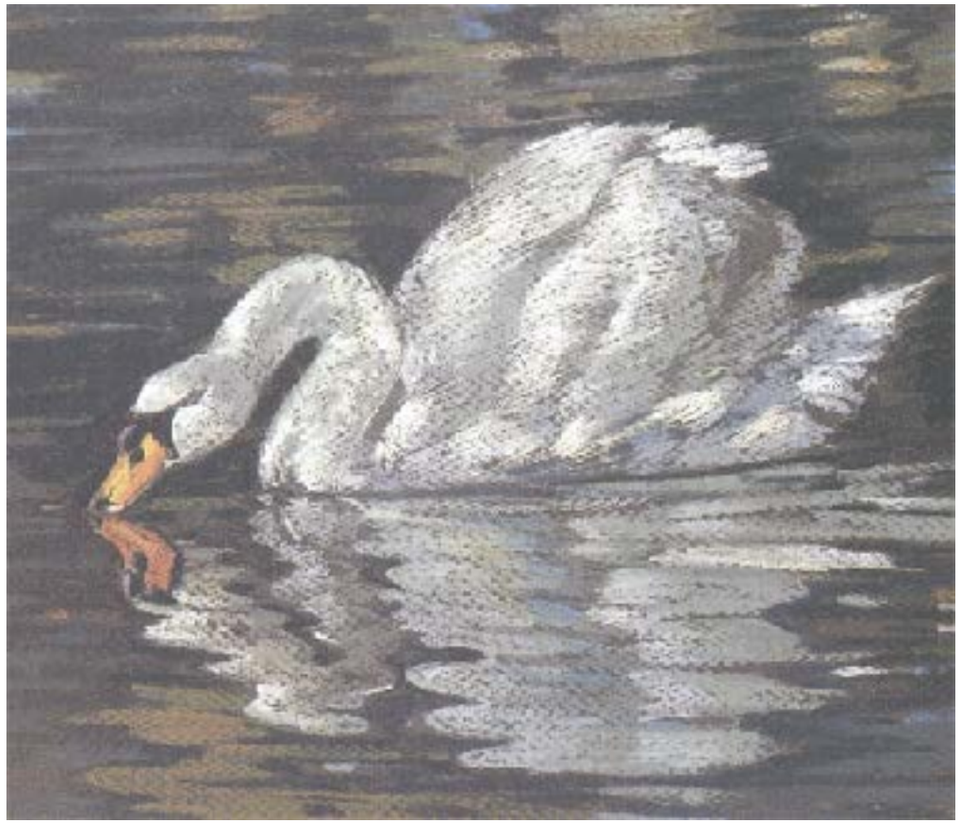
(same texture)

B

Closer to texture

Closer to photo

B’s



Color channels

Input image

Luminance

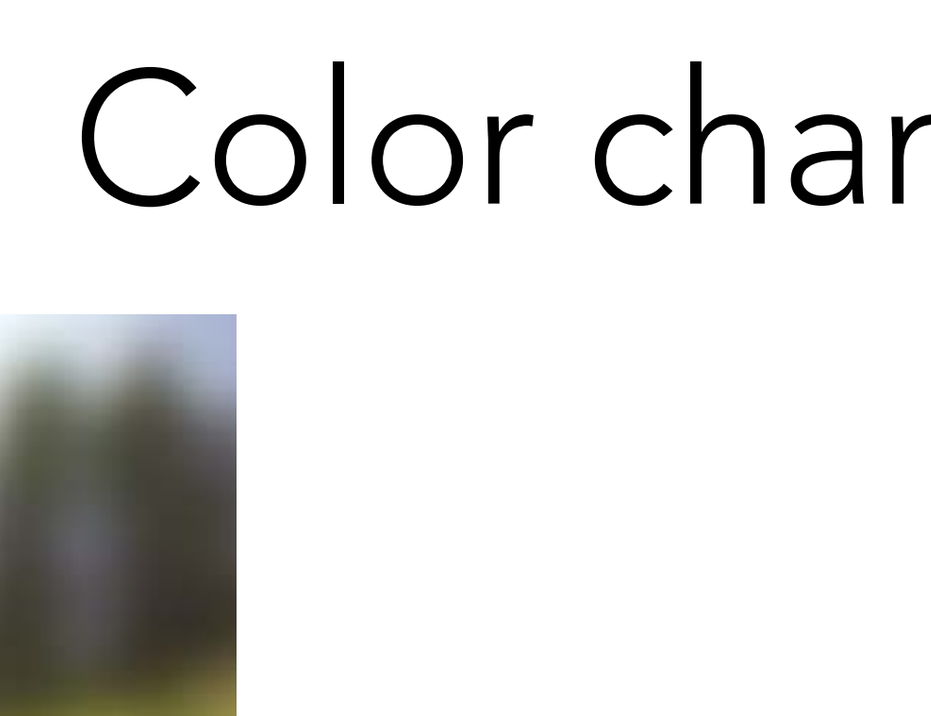
Color channels

Color channels

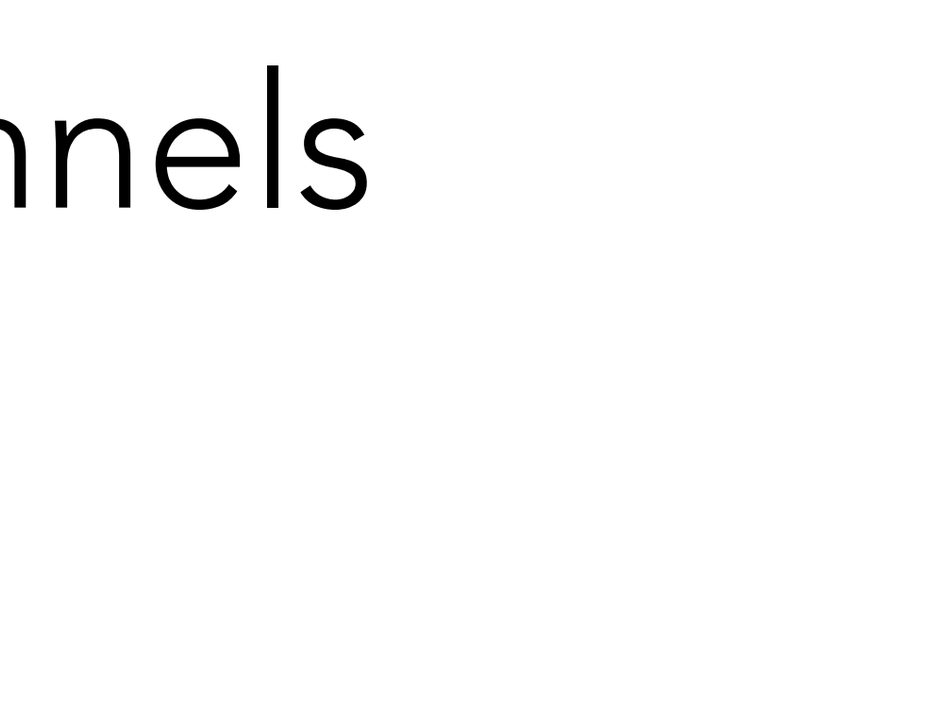
Luminance

Blurry color

Color channels



Blurry luminance



Color channels

Color transfer

Input photo

Input luminance

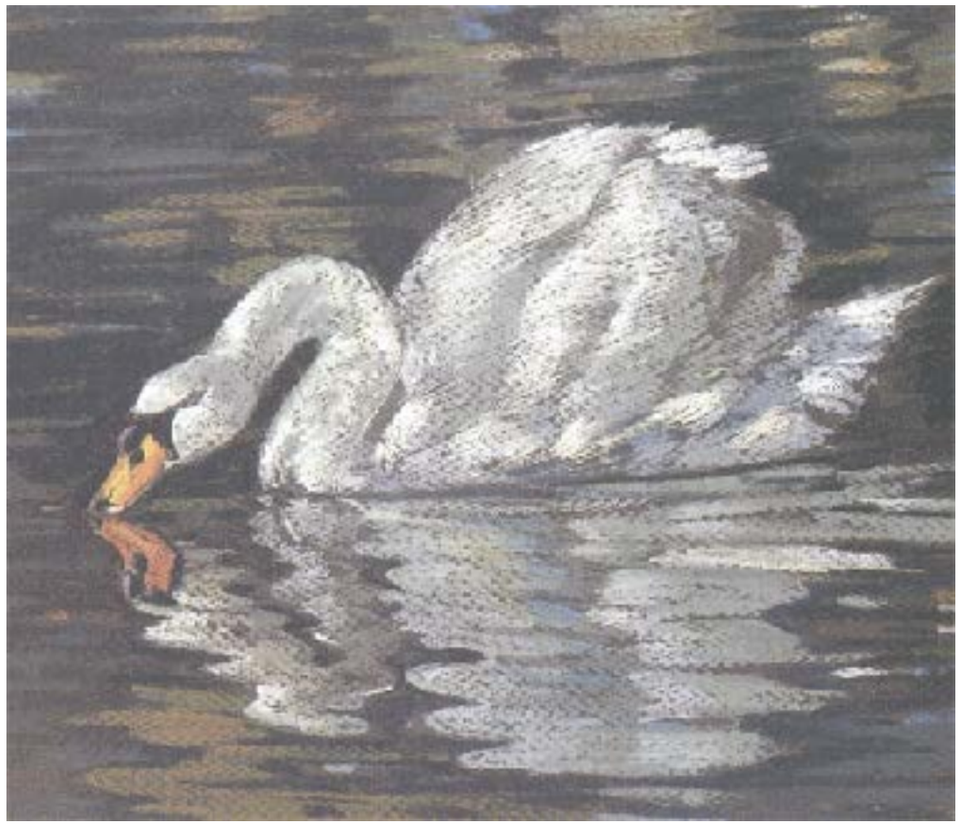
Example luminance

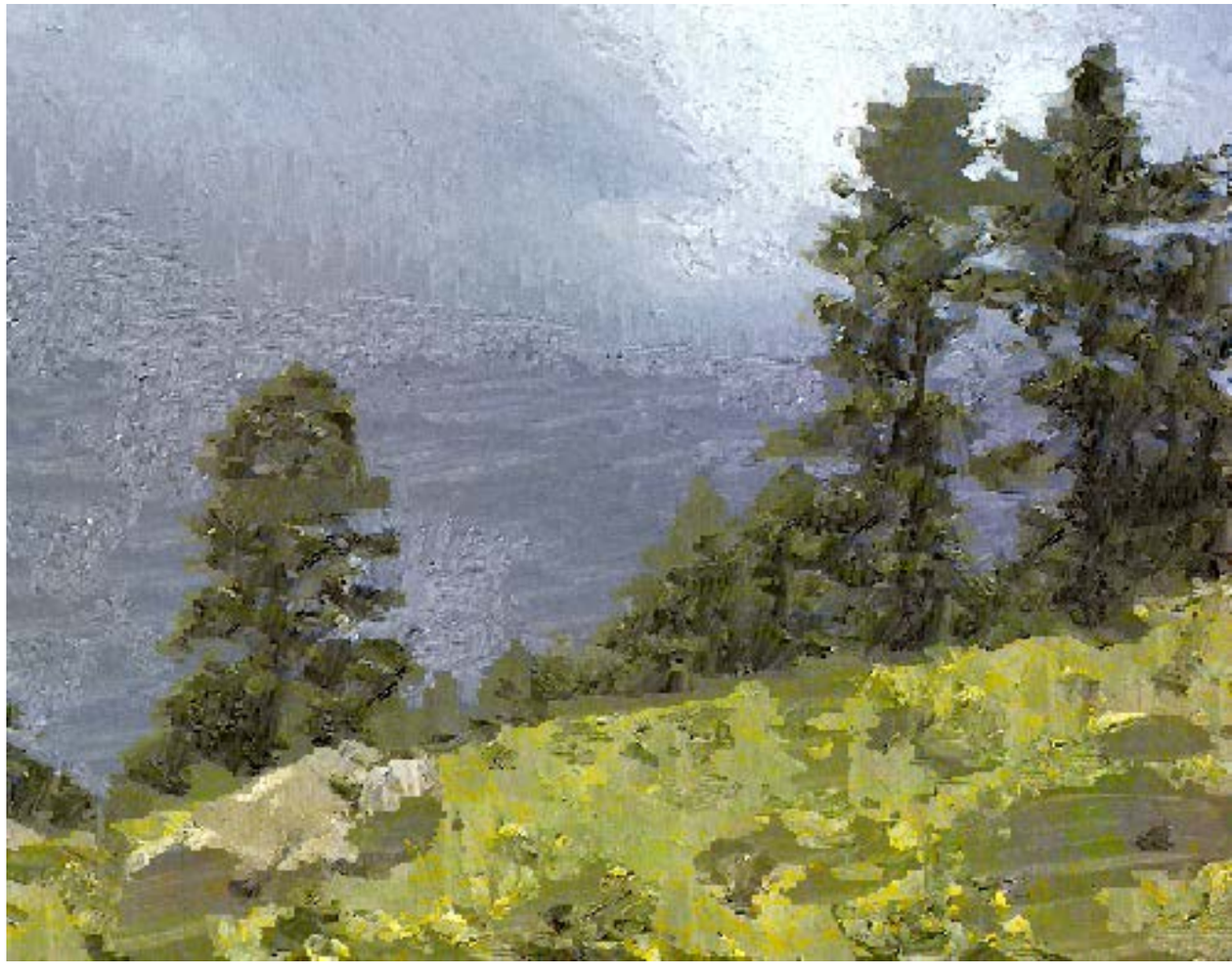
Input colors

+

Output luminance

Output image



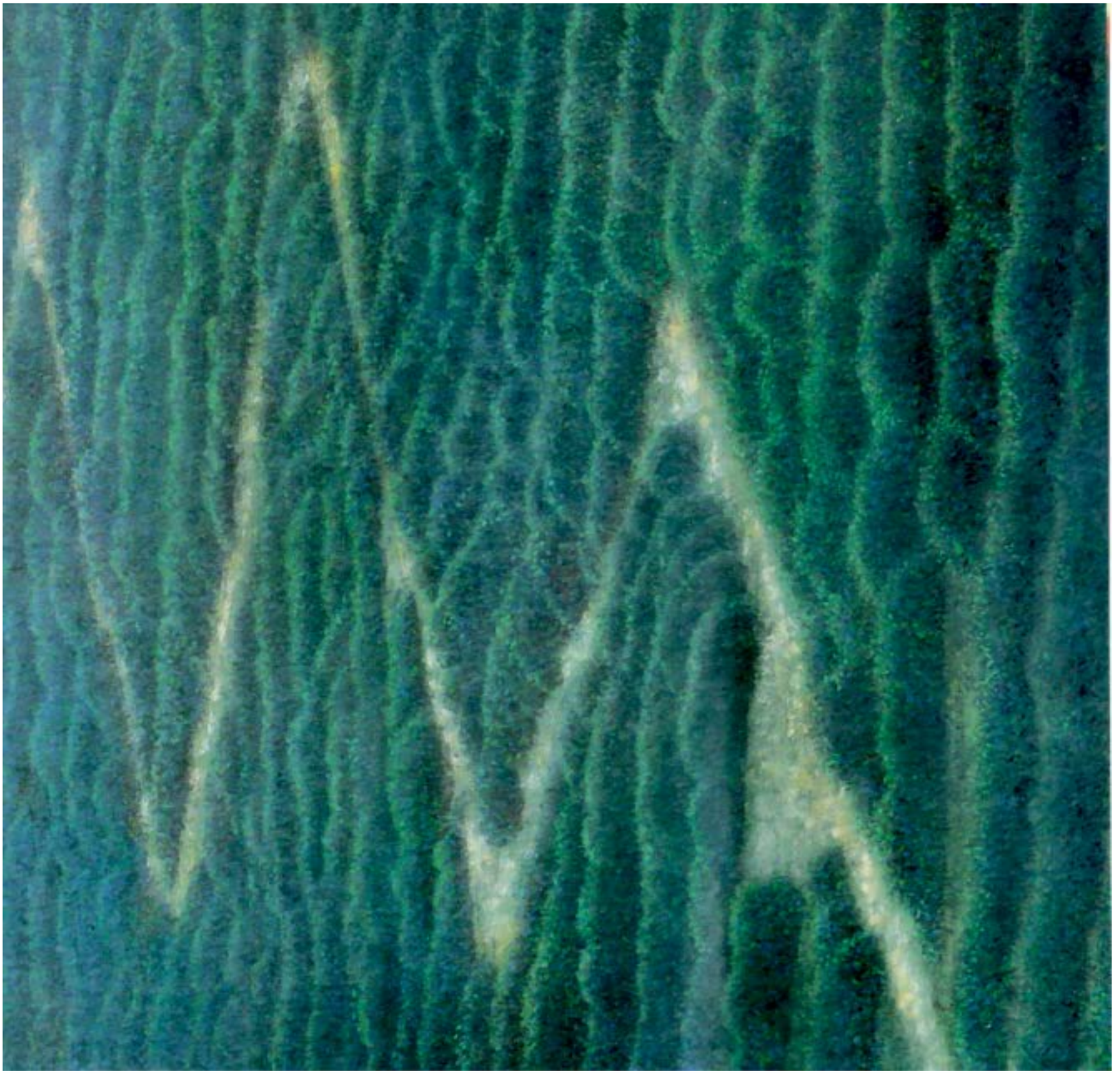


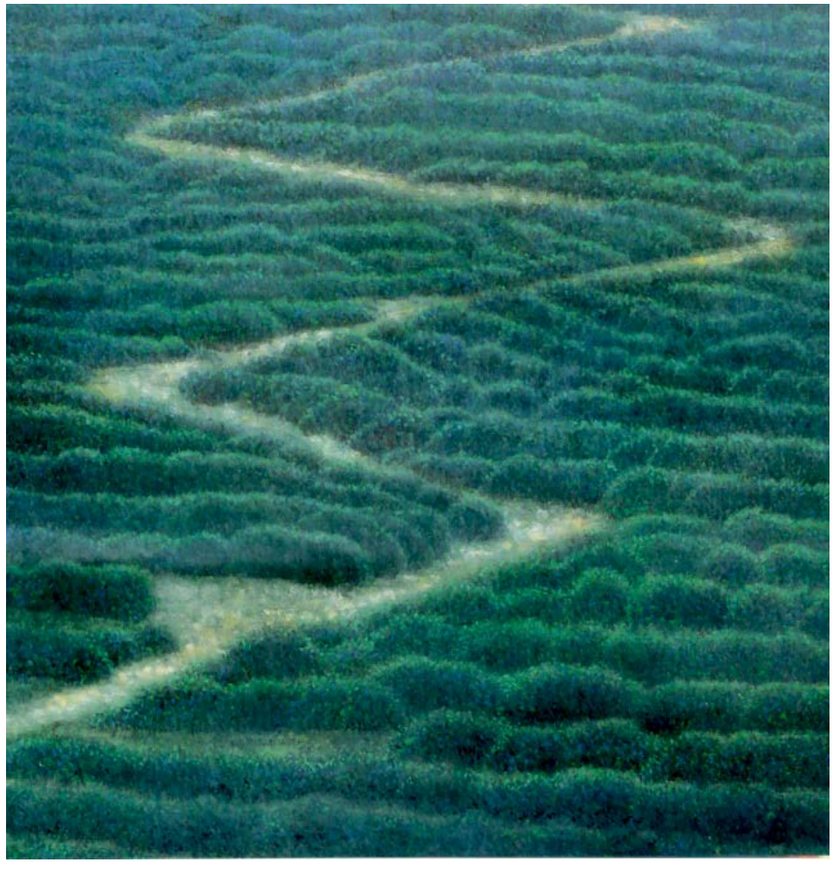
A

A′

B

B′



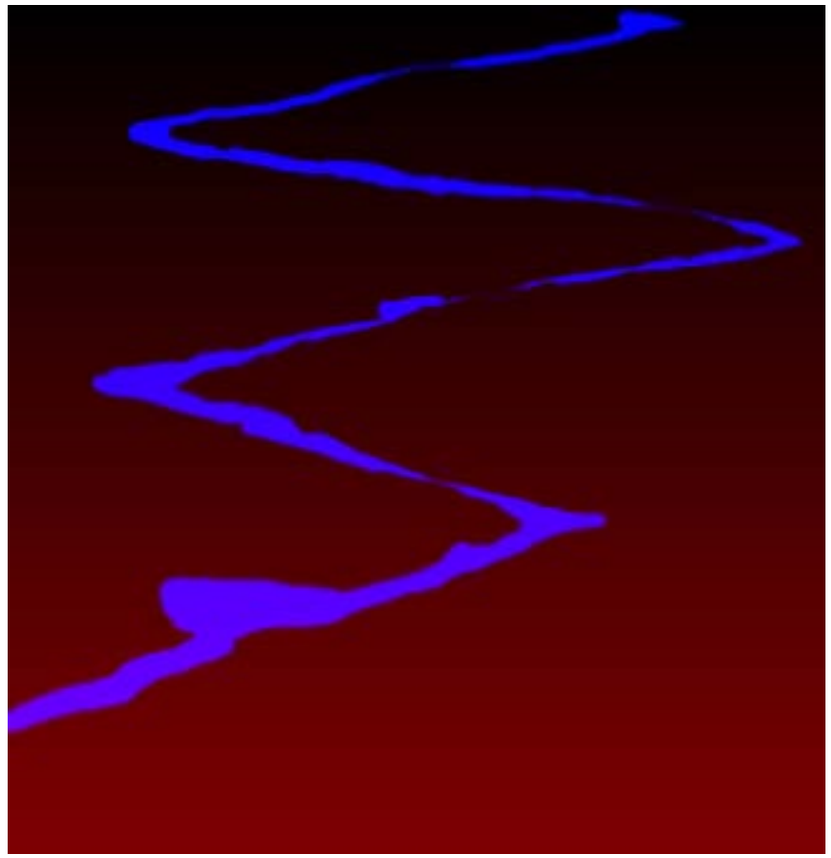


A

A′

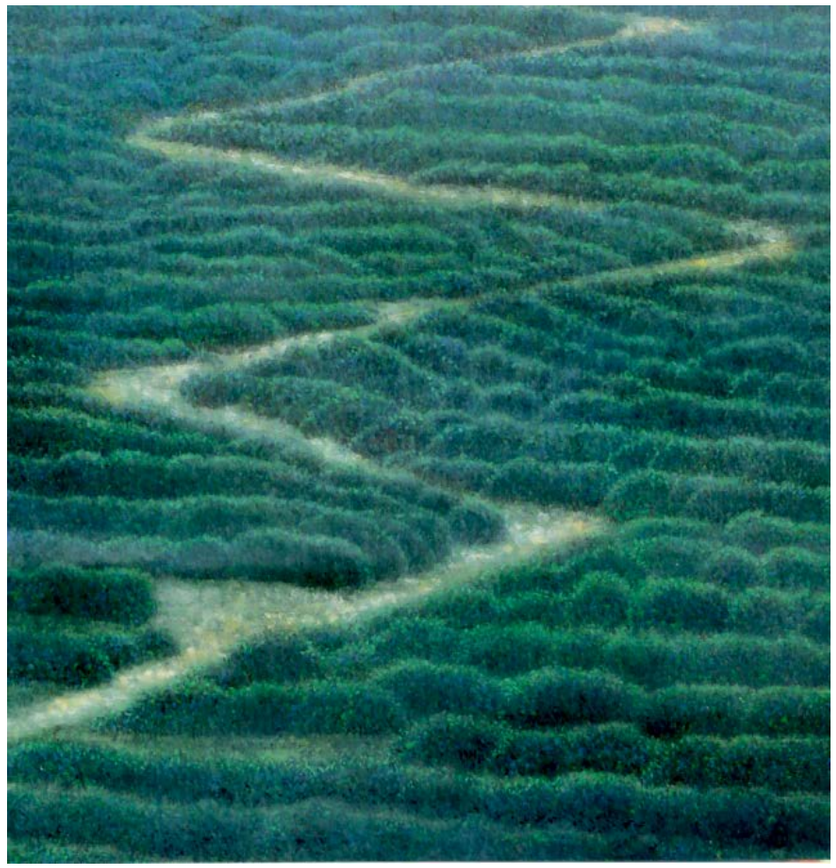
B

B′



A

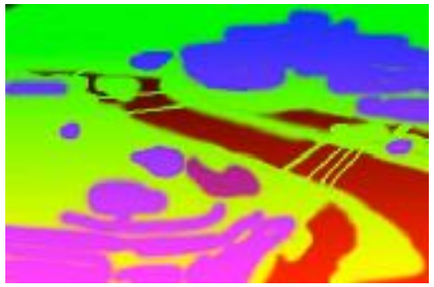
::

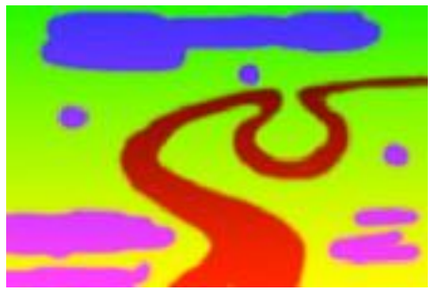


A’

::

::





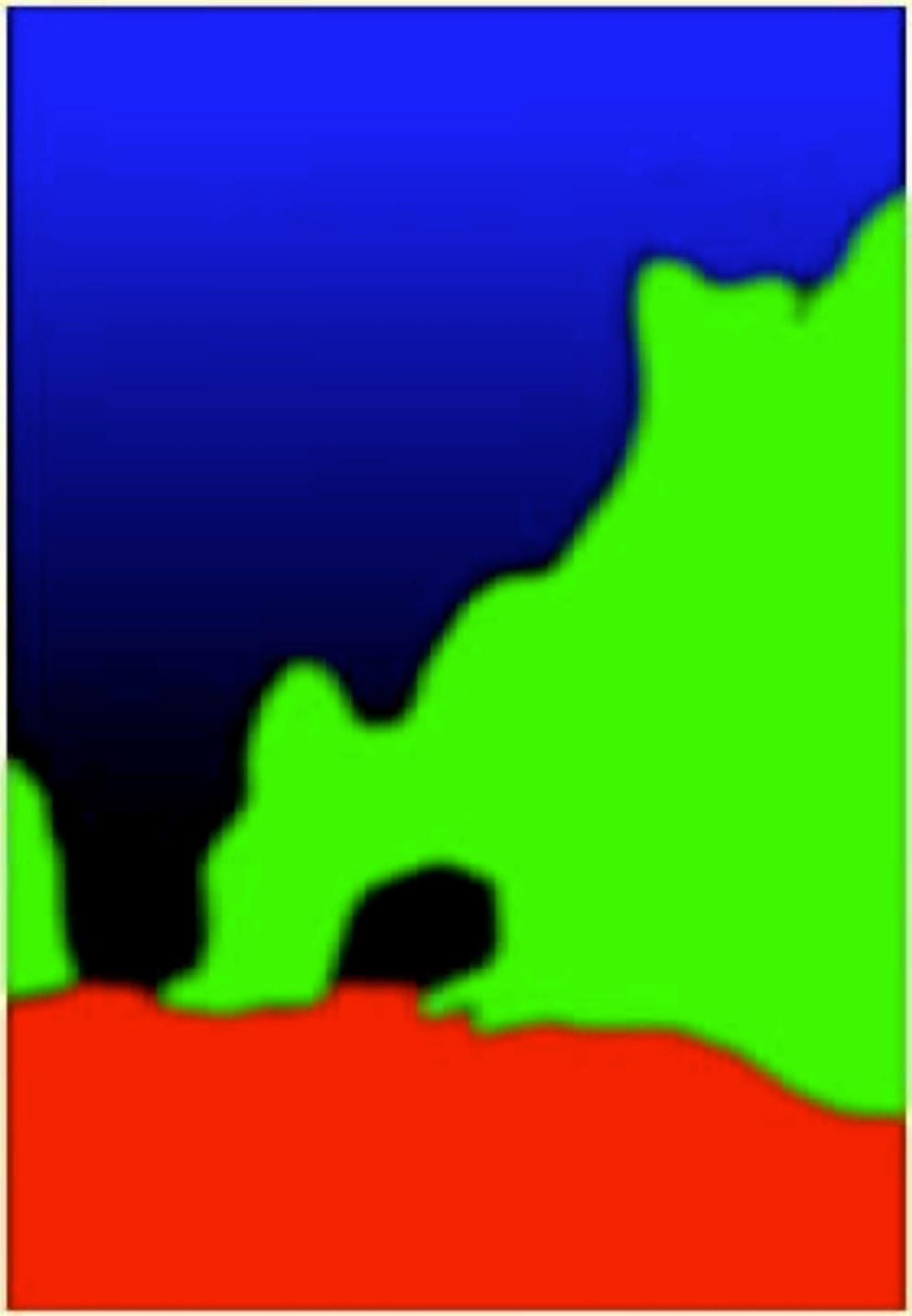
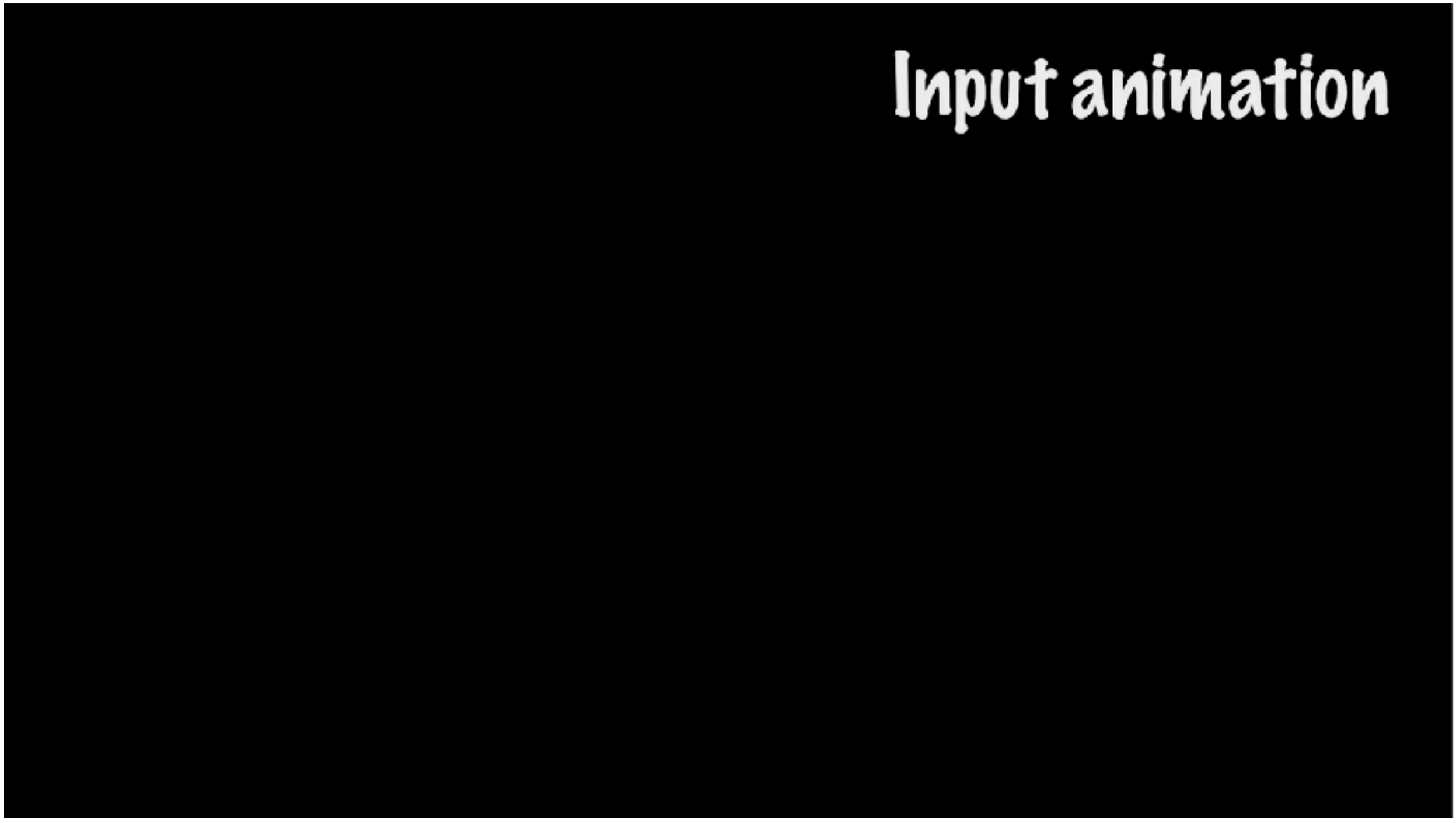


Image Analogies for Animation



Bénard et al. SIGGRAPH 2013

StyLit

Illumination-Guided Example-Based Stylization of 3D

Jakub Fišer [1] Ondřej Jamriška [1] Michal Lukáč [1]

Eli Shechtman [2] Paul Asente [2] Jingwan Lu [2]

Daniel Sýkora [1]

[1] CTU in Prague, FEE

[2] Adobe Research

Neural texture

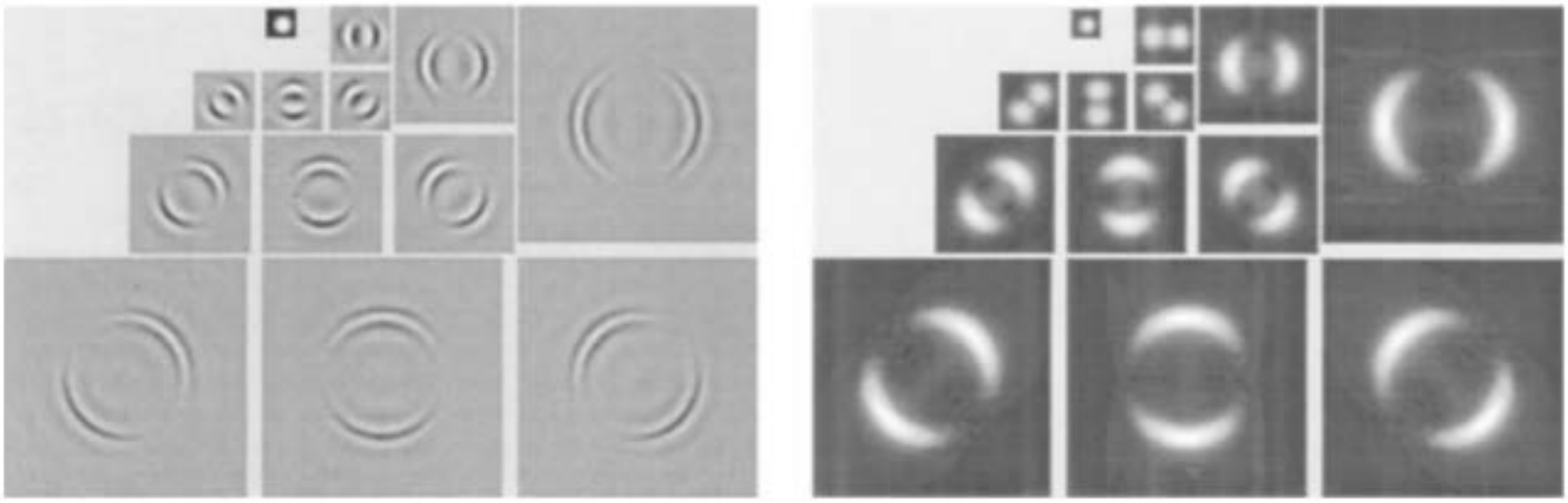
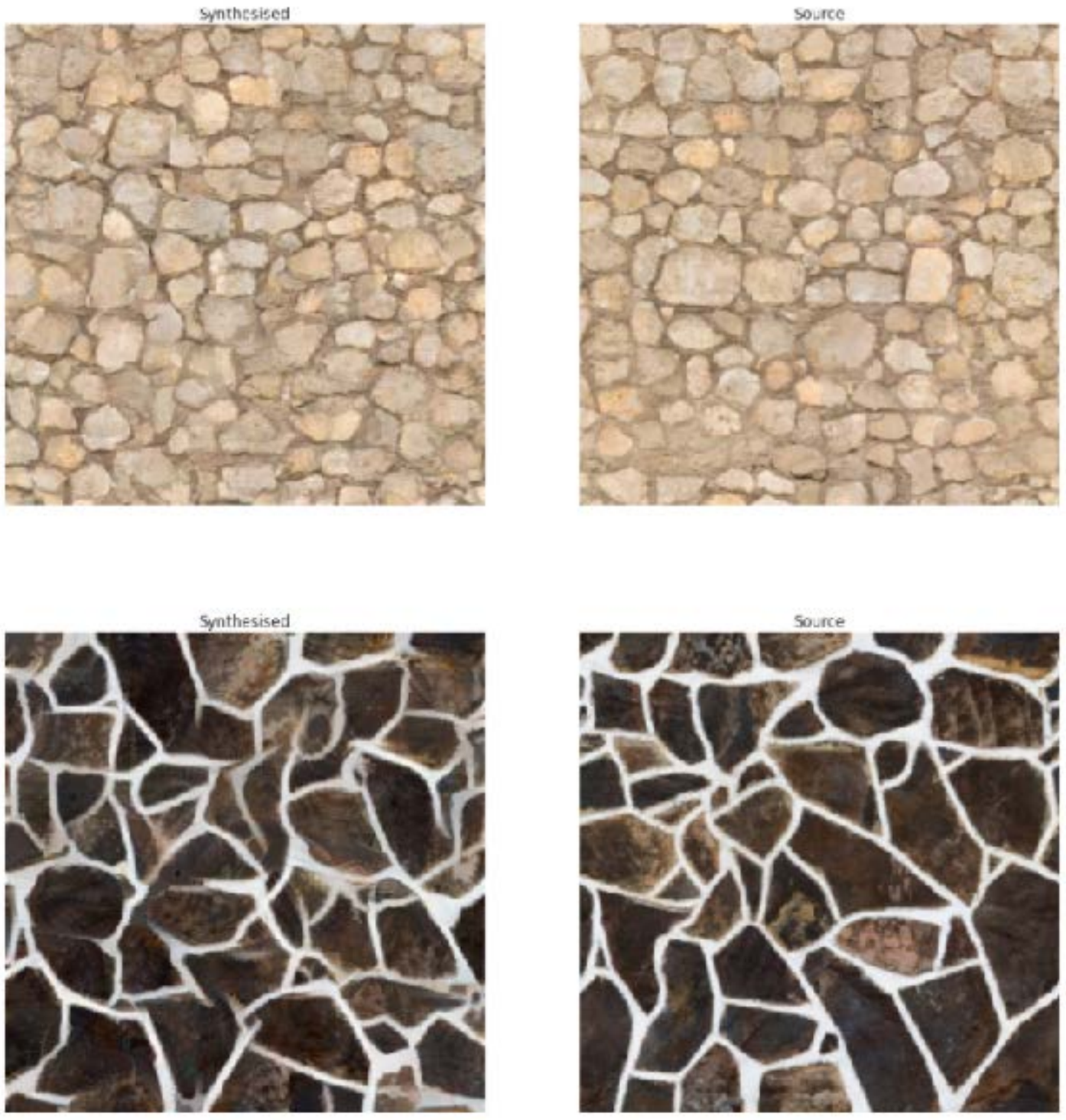


Figure 2. A 3-scale, 4-orientation complex steerable pyramid representation of a disk image. Left: real parts of oriented bandpass images at each scale and the final lowpass image. Right: magnitude (complex modulus) of the same subbands. Note that the highpass residual band is not shown.

Can we model statistical textures with neural networks?

Texture synthesis



Gatys et al., NIPS 2015

Texture synthesis

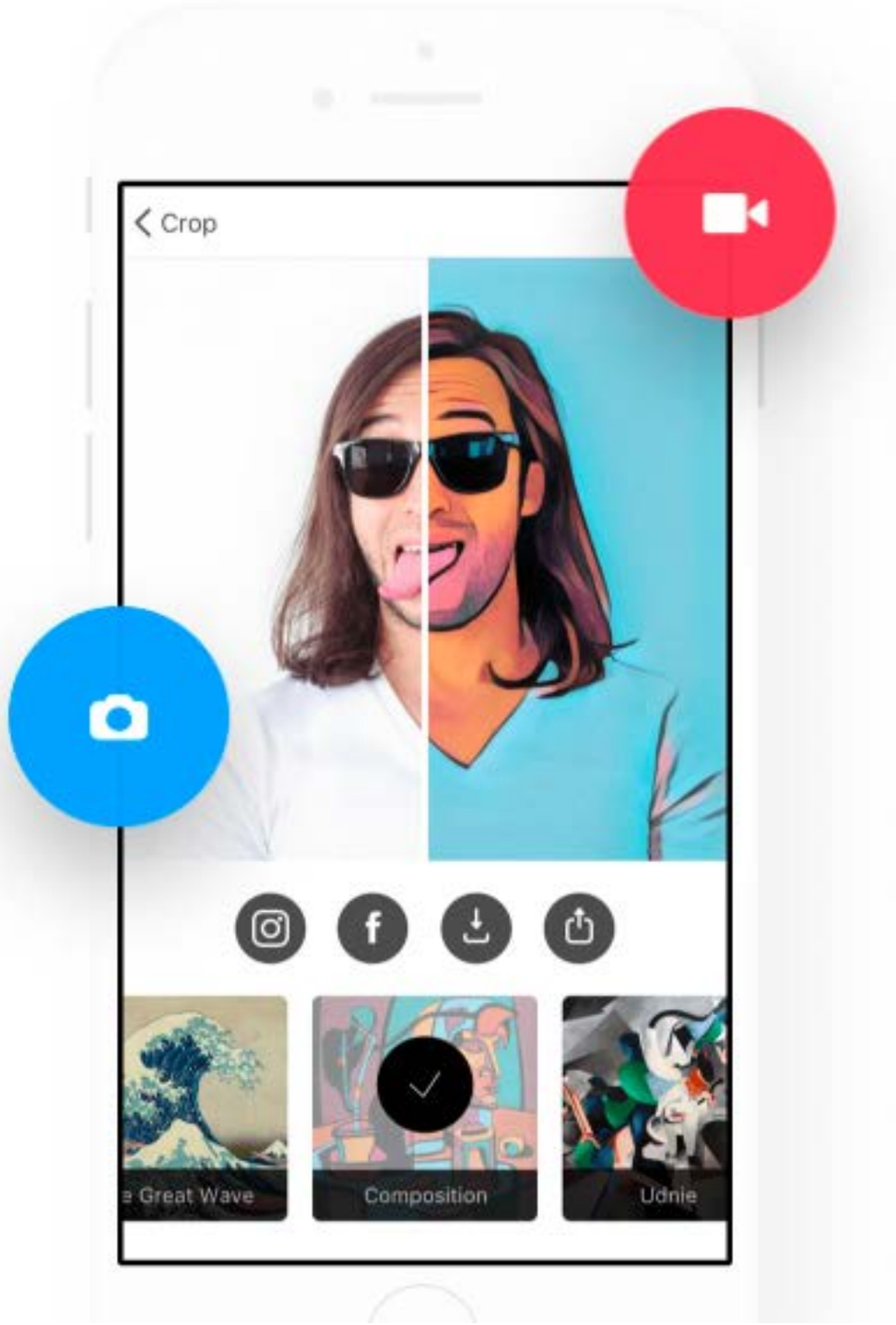
Gatys et al., NIPS 2015

Neural stylization

Neural Style Transfer

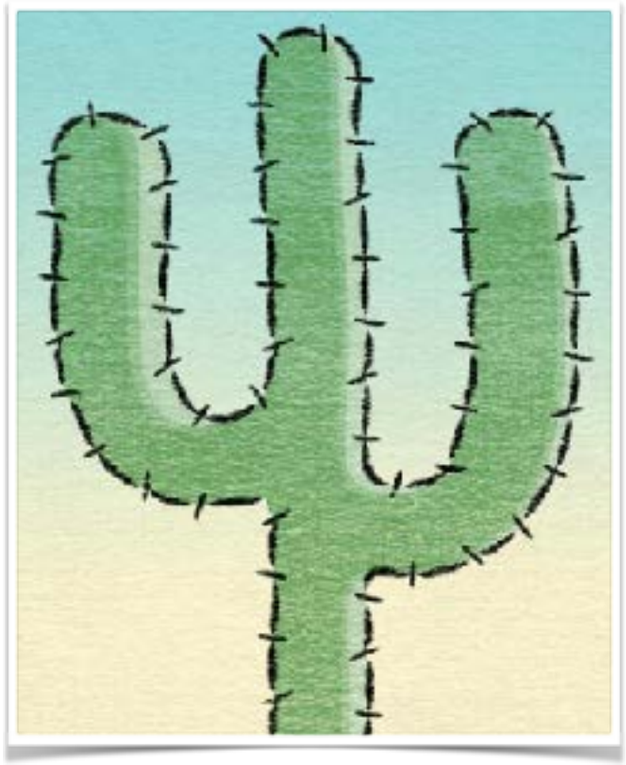
Results

PRISMA


Crop
Great Wave
Composition
Udnie

Verizon LTE 08:55
Search
Yann LeCun shared Mark Zuckerberg's post.
5 mins
Mark is showing a preview of a new "style transfer" technology that works on video in real time on your phone.
It uses deep learning methods (optimized to run on the phone) to make a video take the style of a painting or drawing.
More information on this will appear over the next couple of weeks.
Stay tuned....
Mark Zuckerberg
44 mins
I took this impressionist video of Beast on my phone with a new AI technique called "style transfer". The idea is you show the artificial intelligence a painting and then it draws your photos or videos in that style in real time. Looking forward to getting this in your hands soon!
Write a comment...
Post

Where are we?



Procedural NPR

Patch-Based
(Analogies)

Neural

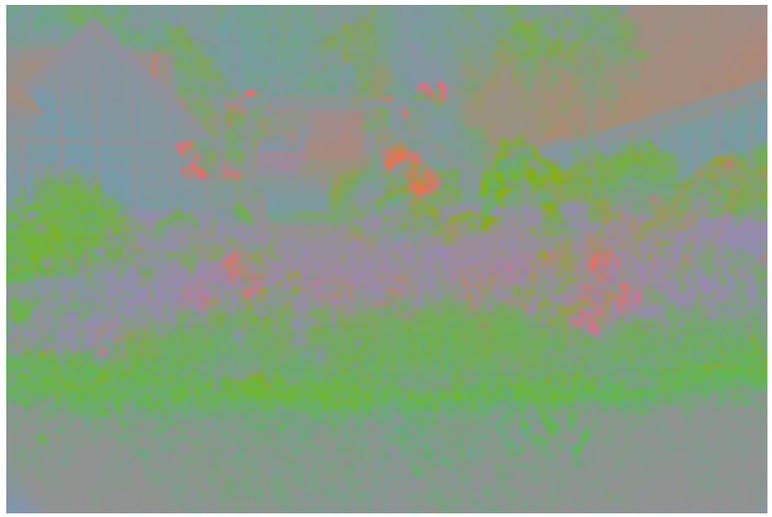
How do we get the best of each?

Adding control to neural stylization

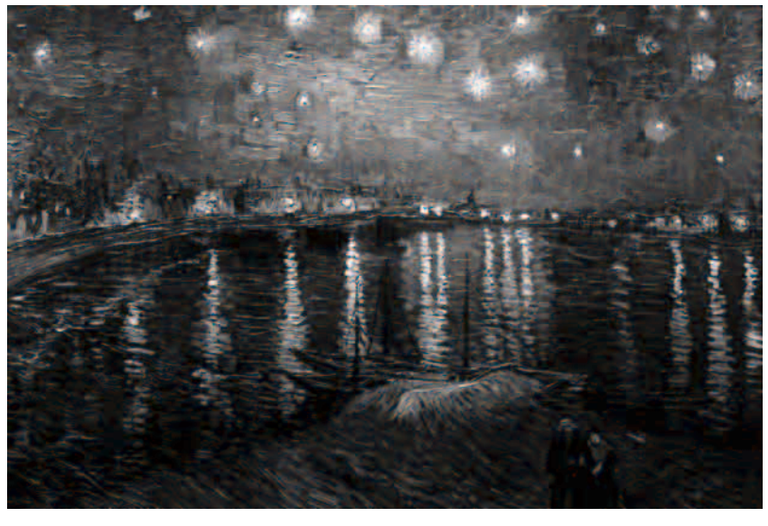
Color Control - Color Preservation

Gatys et al., arXiv 2016

Color Control - Luminance Style Transfer



Stylize



Gatys et al., arXiv 2016

Spatial Control

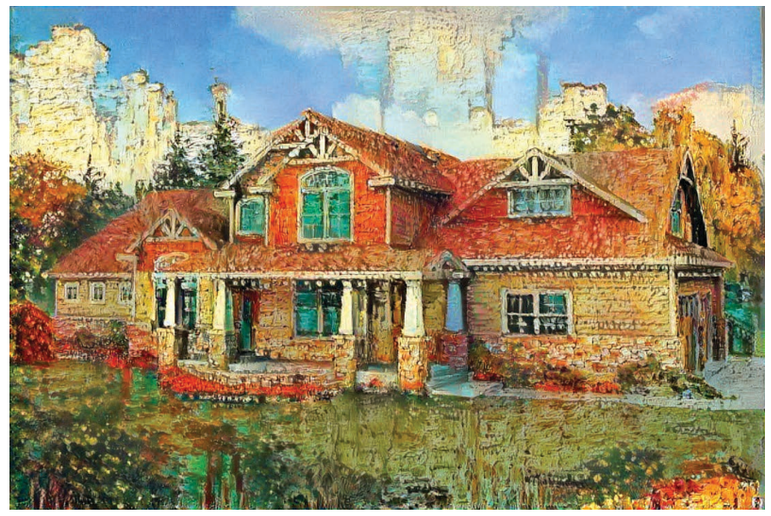
Gatys et al., arXiv 2016

Spatial Control

Gatys et al., arXiv 2016

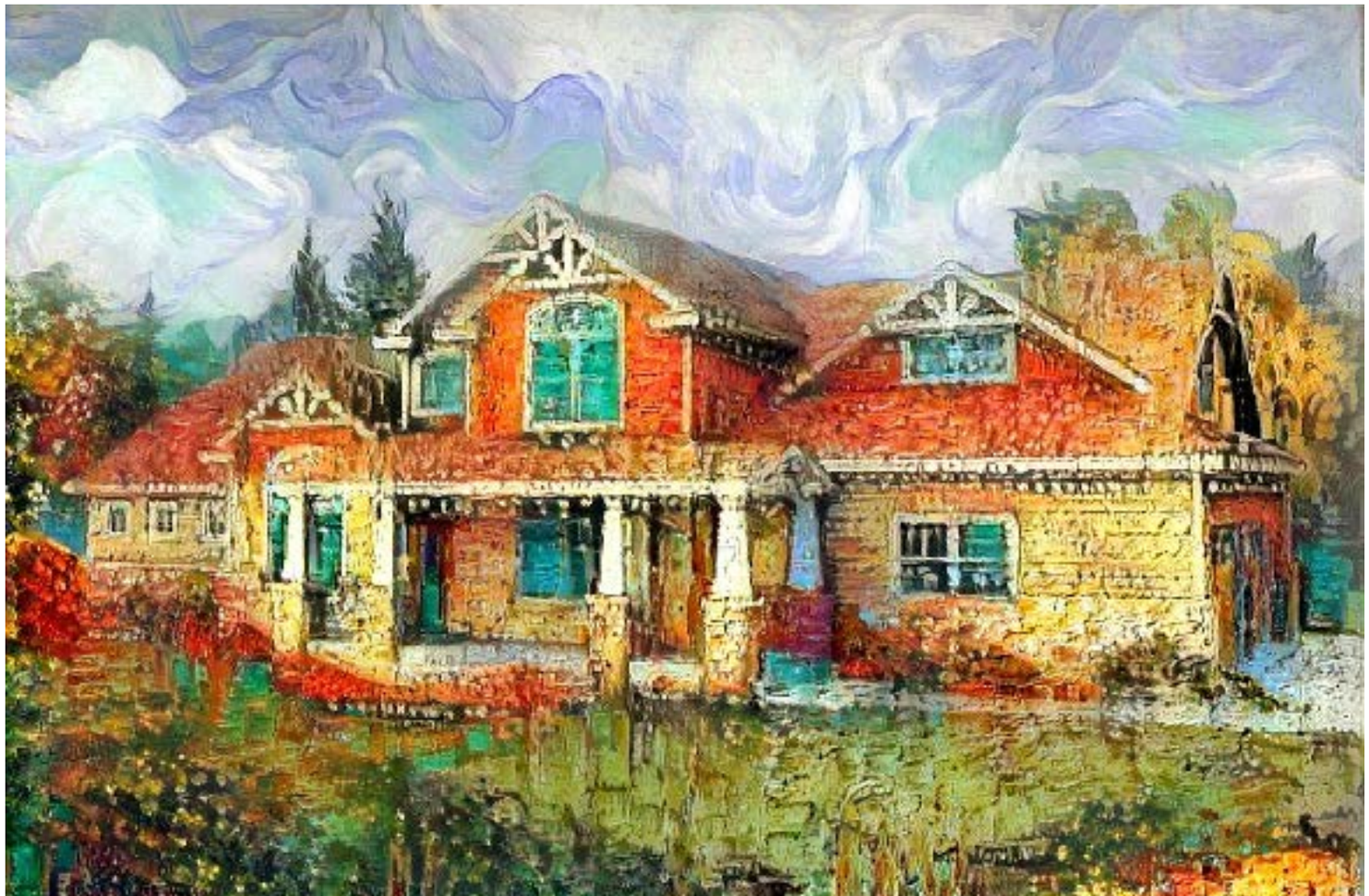
Spatial Control

No control



Guidance Channels

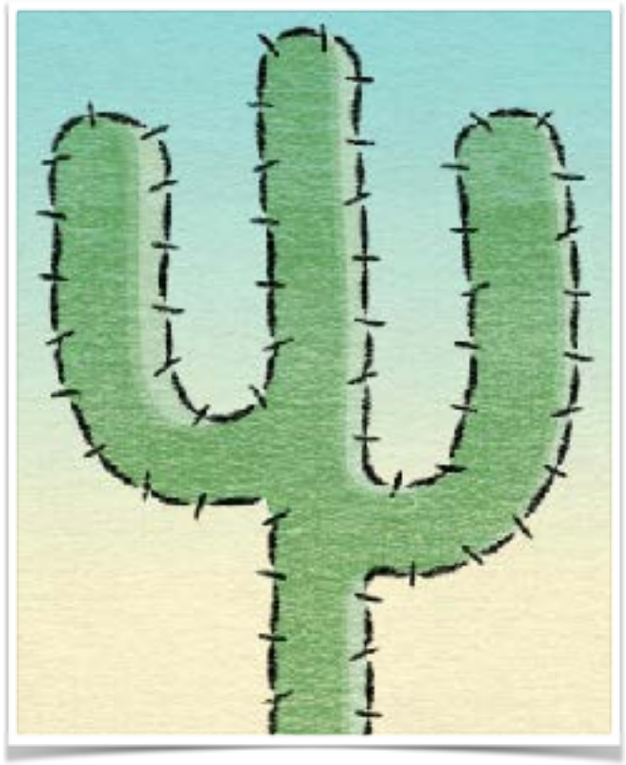
Spatial Control



Gatys et al., arXiv 2016

Neural animation

Where are we?



Procedural NPR

Patch-Based
(Analogies)

Neural

Open question: How do we get the best of each?

Open problems

How do we author images?

Learning style from large datasets

Detailed control of style

Creating 3D animation

Making the details look good

Make the fast methods better

What is style? What is texture?