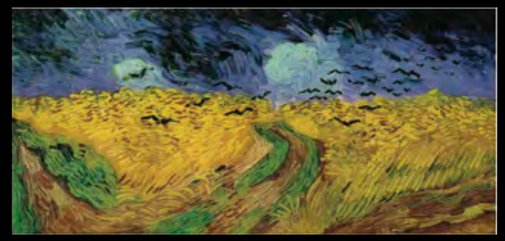
Source Image

Corpus Images



Stylization

Corpus-based Visual Synthesis: An Approach to Artistic Stylization

Parag K. Mital[1] Mick Grierson[1] Tim Smith[2]

[1] *Department of Computing,* Goldsmiths, **University of London**

[2] *Department of Psychological Sciences,* Birkbeck, **University of London**

ACM Symposium On Applied Perception | **23** *August* **2013**

Representation

- Perception must be supported by pre-attentive representations
- Abstract description of objects/scenes
- Numerous theories:
  - *Gestalts*
  - *Geons* (Biederman)
  - *Object files* (Wolfe)
  - *Proto-objects* (Rensink)
  - *Indexicals* (Pylyshyn)
  - *Shapes* (Marr)
  - *Streams* (Bregman)

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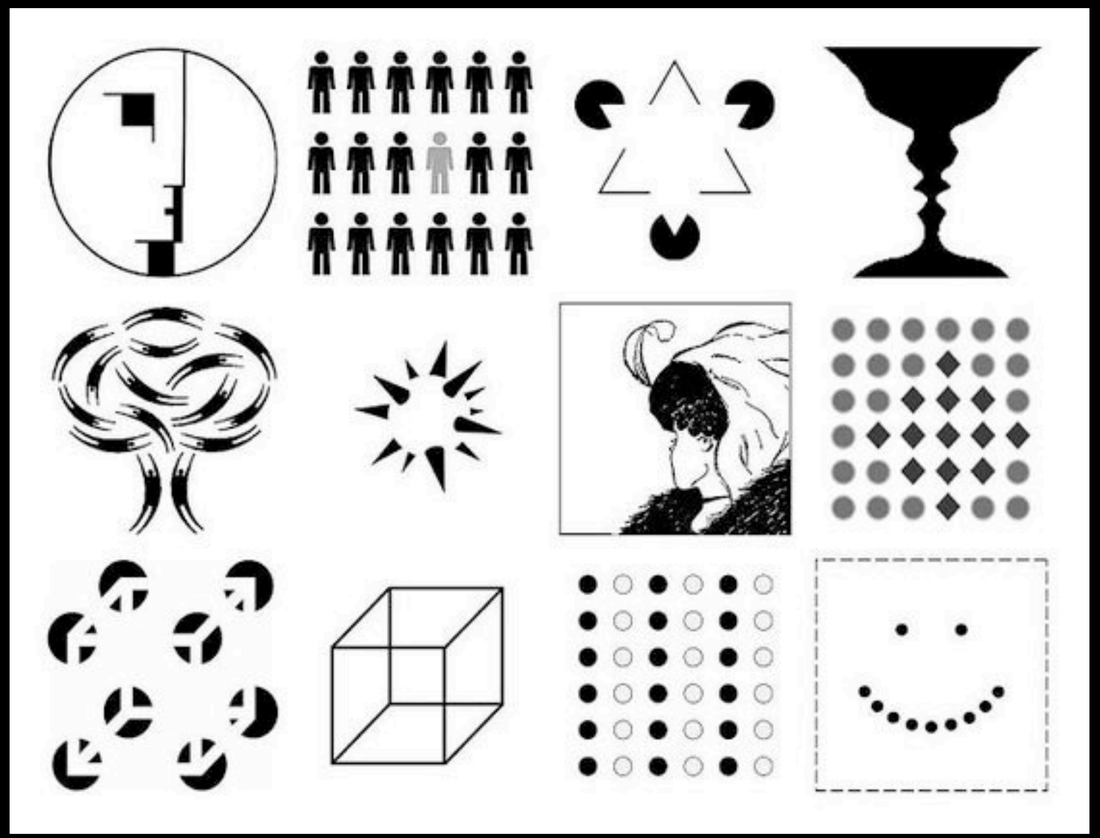

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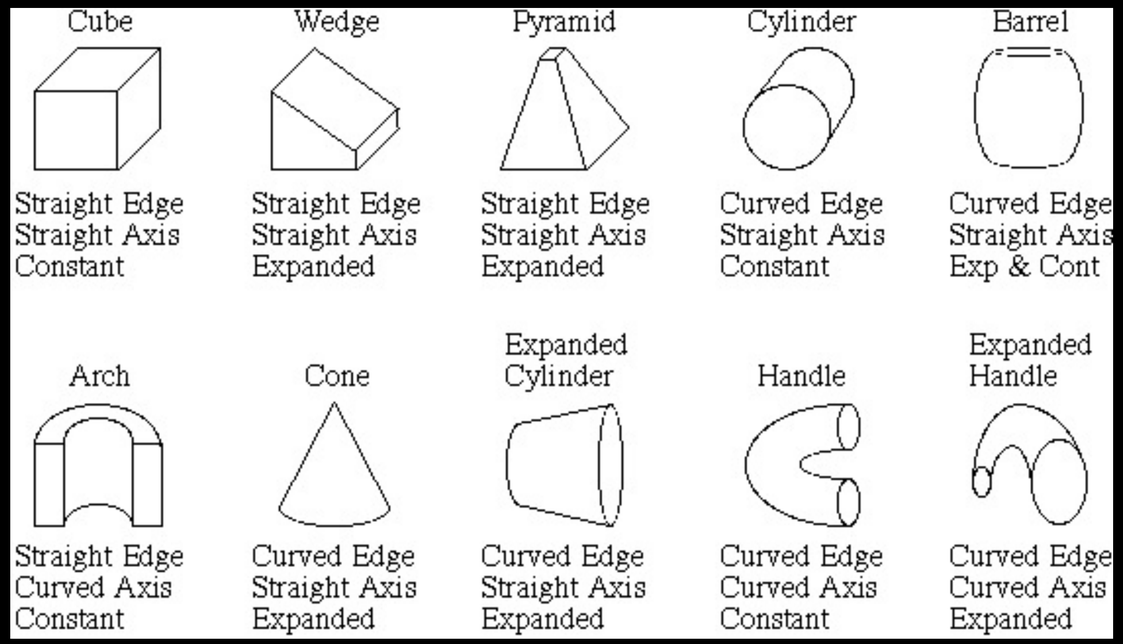

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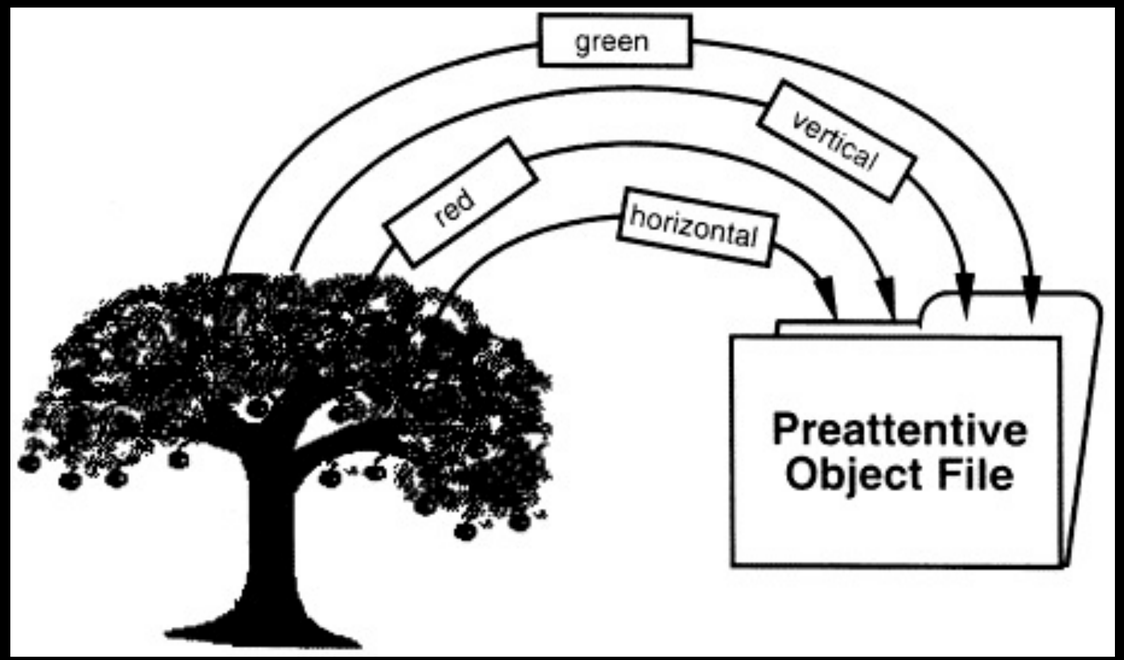

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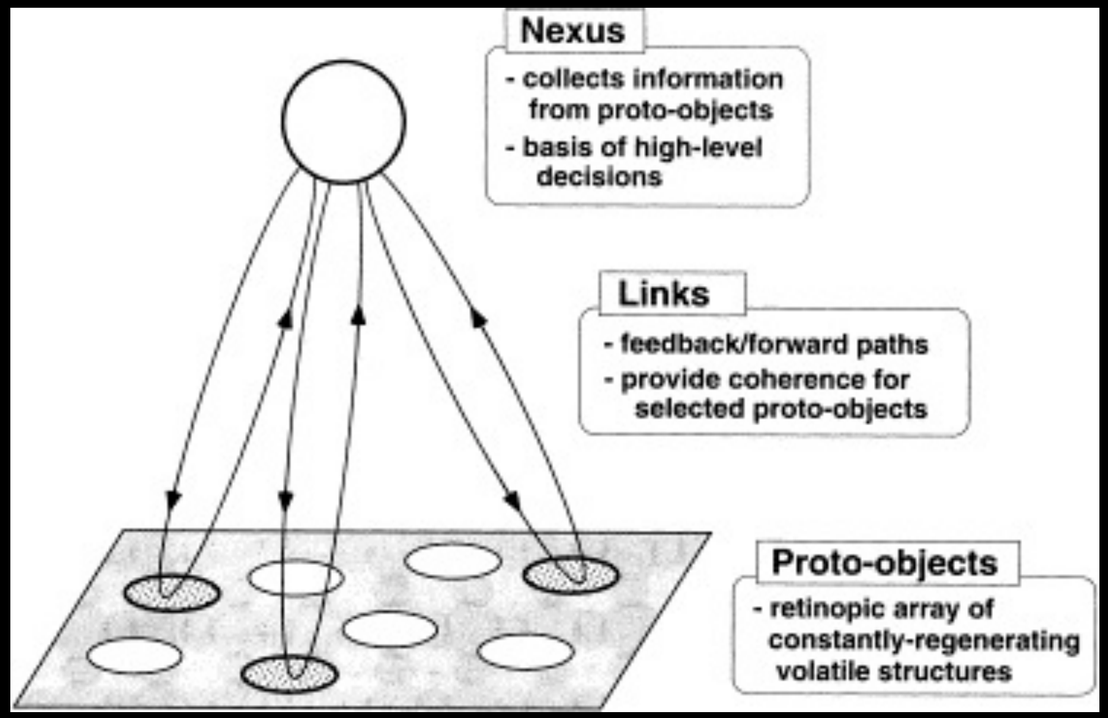

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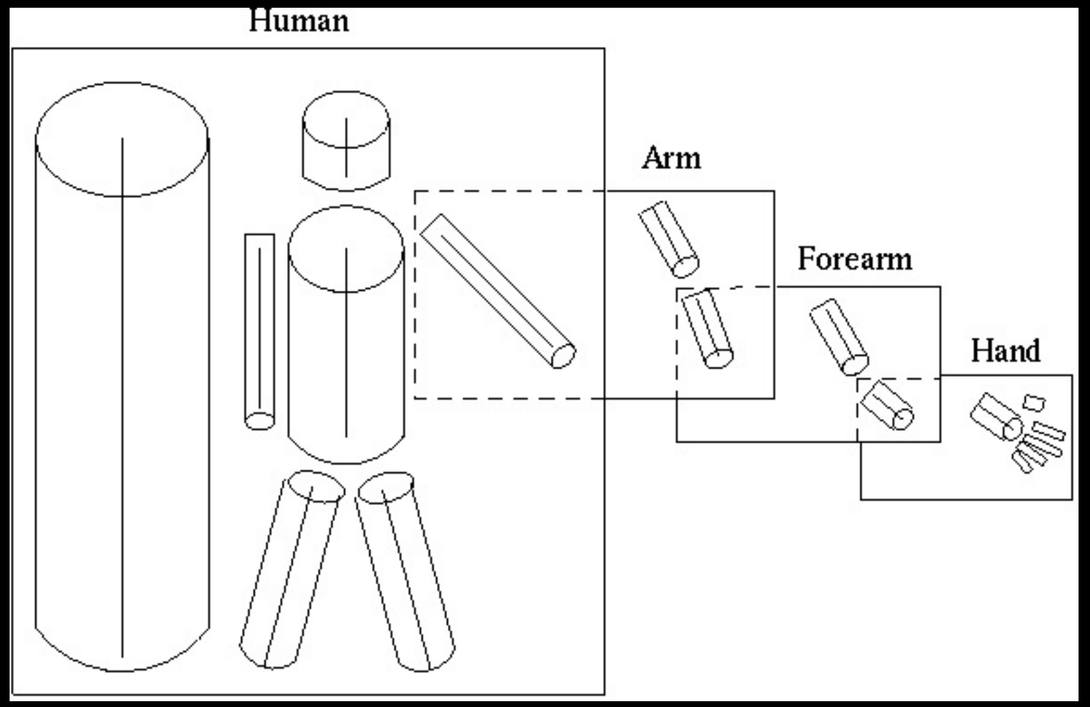

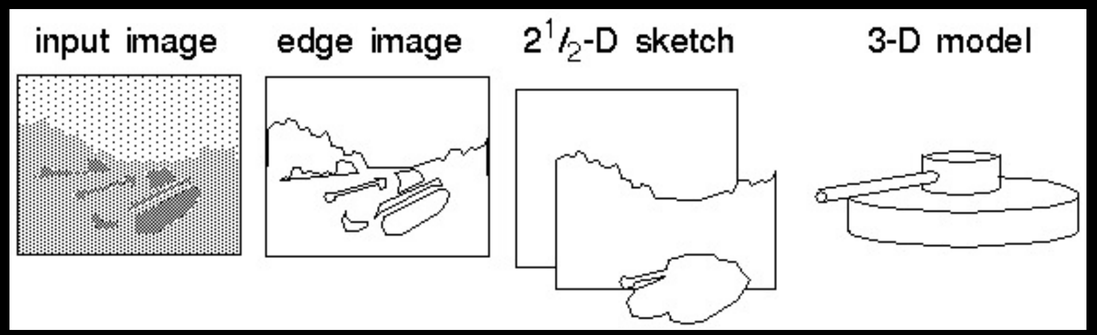

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Representation

- Artists are well aware of the role of abstract representations in perception
- Influence how we look at and where we look in a scene
- Art Movements
  - *Impressionism*
  - *Pointilism*
  - *Cubism*
  - *Orphism*
  - *Expressionism*
  - *Abstract-Expressionism*

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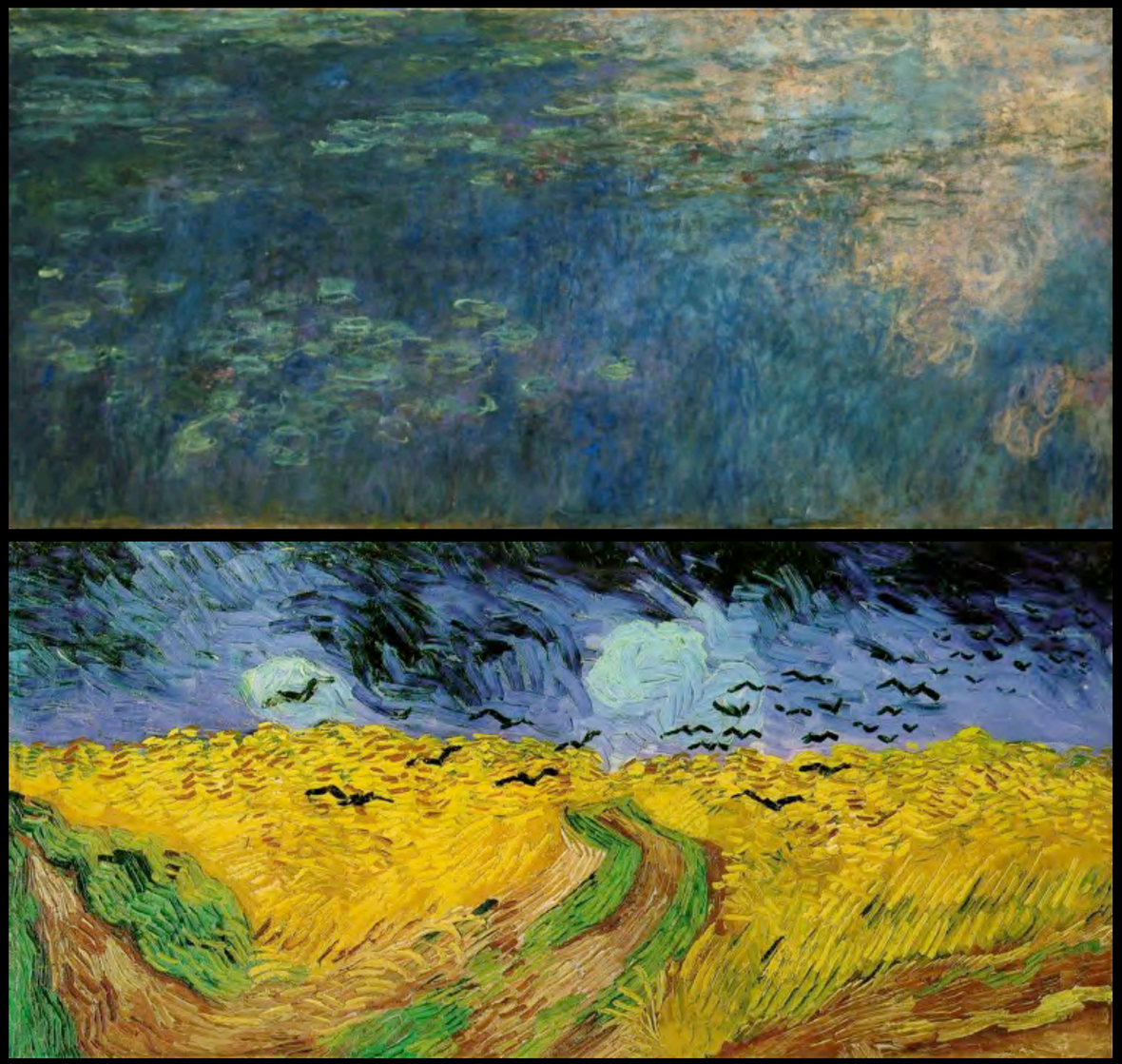

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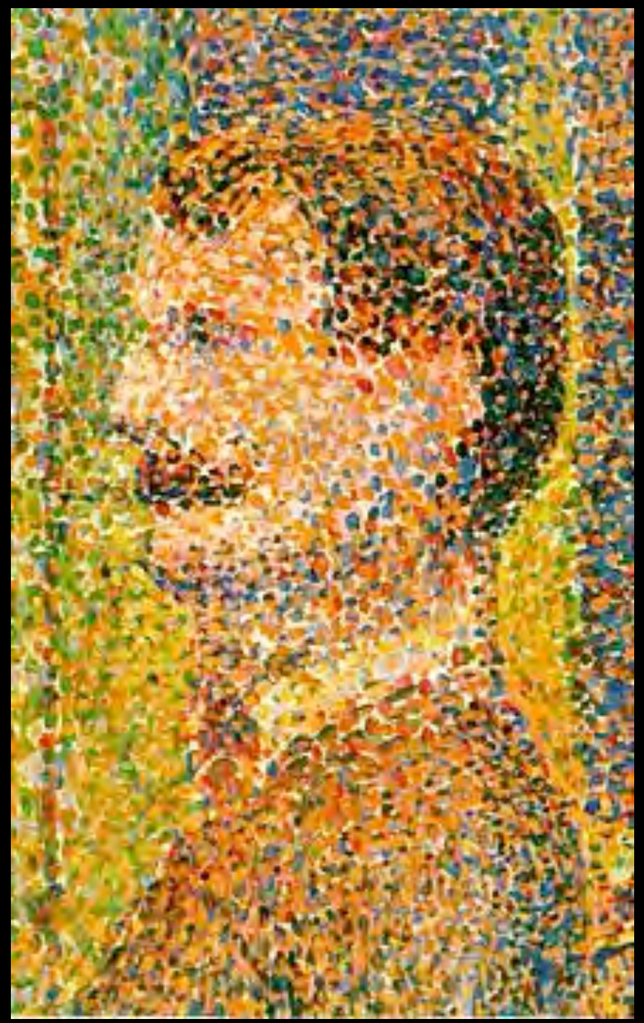

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Related Work

- Filtering / Clustering
- Example-based Images
- Texture-transfer / Patch-based
- Dictionary methods / Collage approaches

Kyprianidis, J. et al., 2012. State of the "Art": A Taxonomy of Artistic Stylization Techniques for Images and Video. *IEEE transactions on Visualization and Computer Graphics*. Available at: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6243138

Problem Statement

- Create automated artistic stylizations of images / videos using an understanding of the role of abstract representations in art and perception
- Allow for a range of styles through a simple set of parameters
- Needs to be fast in order to explore different styles quickly / run in real-time

- Our approach
  - Build corpus of abstract representations from user chosen images
  - Match target image's abstract representations to nearest ones in corpus
  - Synthesize target image using closest matches
  - Interact with a simple set of parameters effecting representation detection and synthesis

Outline

- CBVS Framework
- Results for Images / Videos
- Extensions
  - Memory Mosaicing
  - Augmented Reality Hallucinations
  - PhotoSynthesizer (iOS app)
- Conclusion

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CBVS Framework

$$\mathbf{R_C} = \{R_1, R_2, ..., R_{N_C}\}$$

- **Build** corpus of abstract representations from user chosen images
- Match target image's abstract representations to nearest ones in corpus
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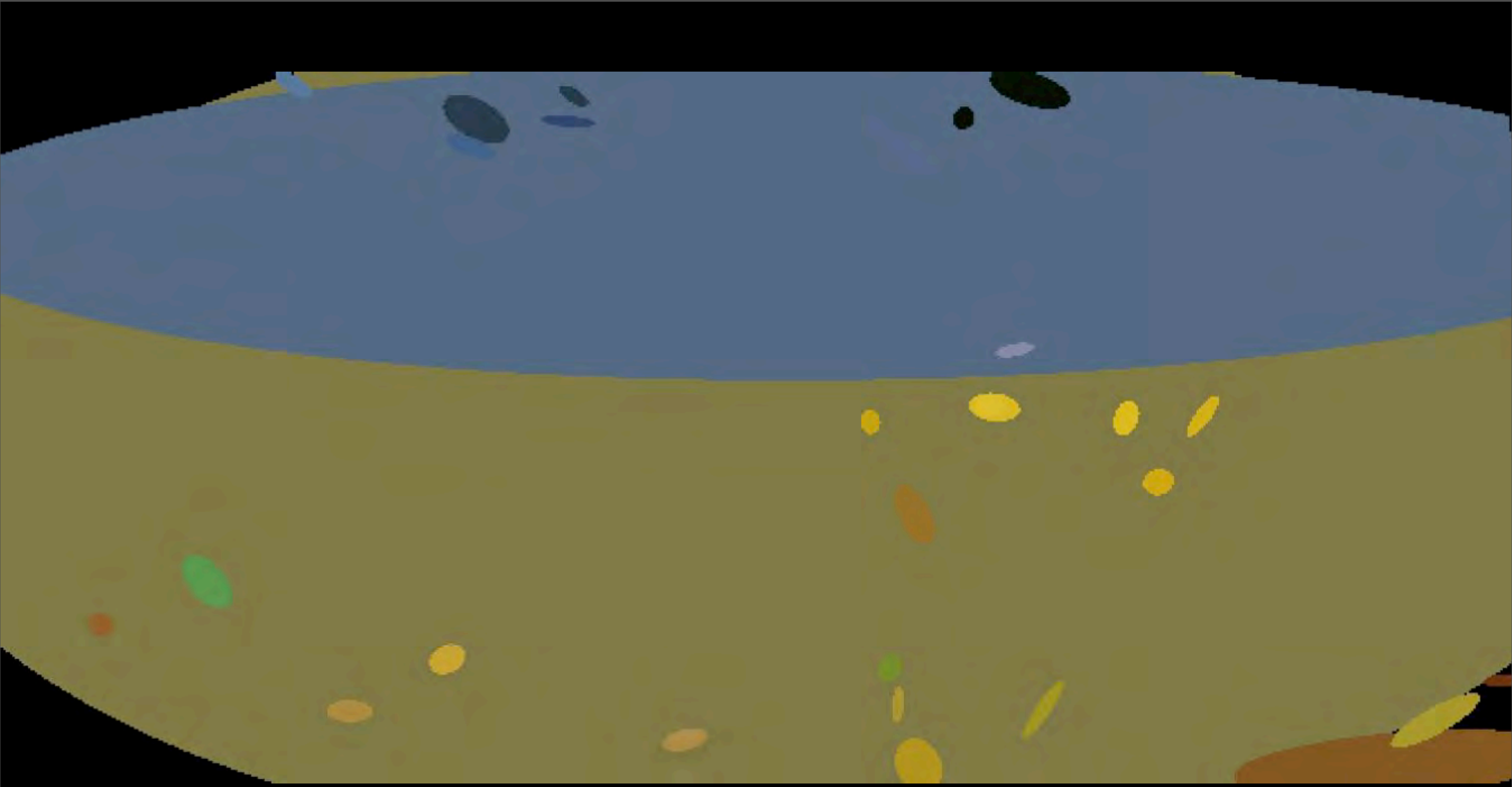
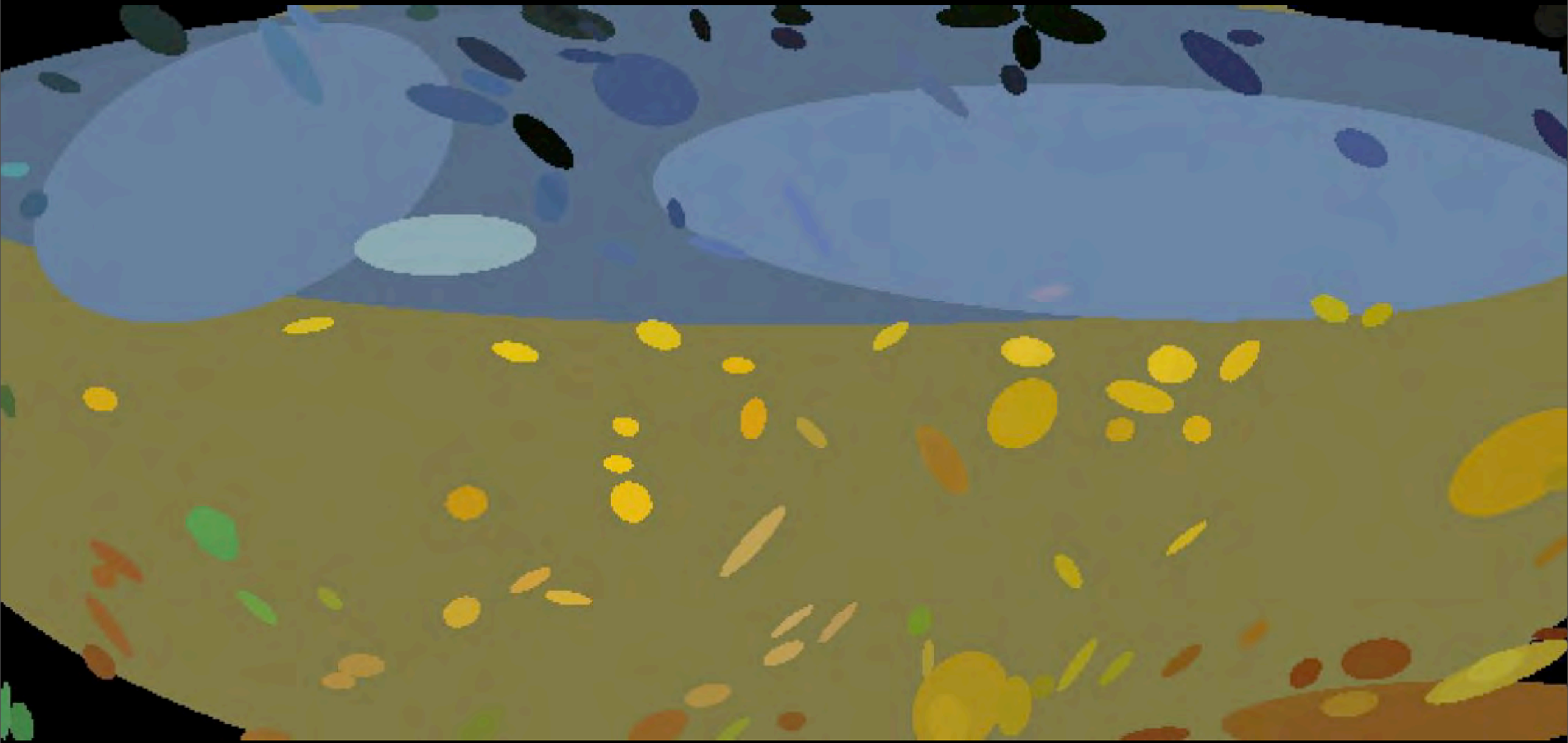
Building the Corpus

- Need to represent:
  - Sparse/Dense strokes
  - Small/Large strokes
  - Watershed?
  - Posterization?
  - Mean-Shift?

Building the Corpus

- Maximally Stable Color Regions
  - No need for multiple scale detections
  - Implicit ordering of regions
  - Simple set of parameters for discovering sparse/dense small/large strokes
  - Fast/Robust across multiple views (used in video tracking)
  - Similar process to the unconscious representations as theorized before





Increasing timesteps
=
Denser detection
More expressive corpus

CBVS Framework

$$\mathbf{R_C} = \{R_1, R_2, ..., R_{N_C}\}$$

?

$$\mathbf{R_T} = \{R_1, R_2, ..., R_{N_T}\}$$

- Build corpus of abstract representations from user chosen images
- Match target image's abstract representations to nearest ones in corpus
- Synthesize target image using closest matches
- Interact with a simple set of parameters effecting representation detection and synthesis

Matching

- Need to match regions in target to similar ones in corpus
- Describe Shape and Color
  - Use Euclidean distance for shape values
  - Use Perceptual distance for color values (CIEDE2000 formula)
  - Nearest neighbor matching

Matching

$$d_{R_i} = \left(\mu_{00}, \eta_{11}, \eta_{20}, \eta_{02}, L, a^*, b^*\right)$$

$$\eta_{ij} = \frac{\mu_{ij}}{\mu_{00}^{\left(1+\frac{i+j}{2}\right)}}$$

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$$d(R_t, R_c) = d_s(R_t, R_c) + d_c(R_t, R_c)$$

CBVS Framework

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Synthesis

$$d(R_t, R_c) = d_s(R_t, R_c) + d_c(R_t, R_c)$$

- From largest to smallest target region
  - Find nearest neighbor
    - Translate
    - Rotate
    - Scale
    - Blend

Synthesis

- From largest to smallest target region
  - Find nearest neighbor
  - Translate
  - Rotate
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  - Blend

$$\mathbf{T} = \text{centroid}_{R_t} - \text{centroid}_{R_c}$$

Synthesis

- From largest to smallest target region
  - Find nearest neighbor
  - Translate
  - Rotate
  - Scale
  - Blend

$$\Theta = \frac{1}{2} * \arctan \frac{2 * \frac{\mu_{11}}{\mu_{00}}}{\frac{\mu_{20}}{\mu_{00}} - \frac{\mu_{02}}{\mu_{00}}}$$

Synthesis

$$S_x = \frac{\text{width}_{R_T}}{\text{width}_{R_C}}$$

$$S_y = \frac{\text{height}_{R_T}}{\text{height}_{R_C}}$$

- From largest to smallest target region
  - Find nearest neighbor
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Synthesis

- From largest to smallest target region
  - Find nearest neighbor
  - Translate
  - Rotate
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  - Blend

Interaction

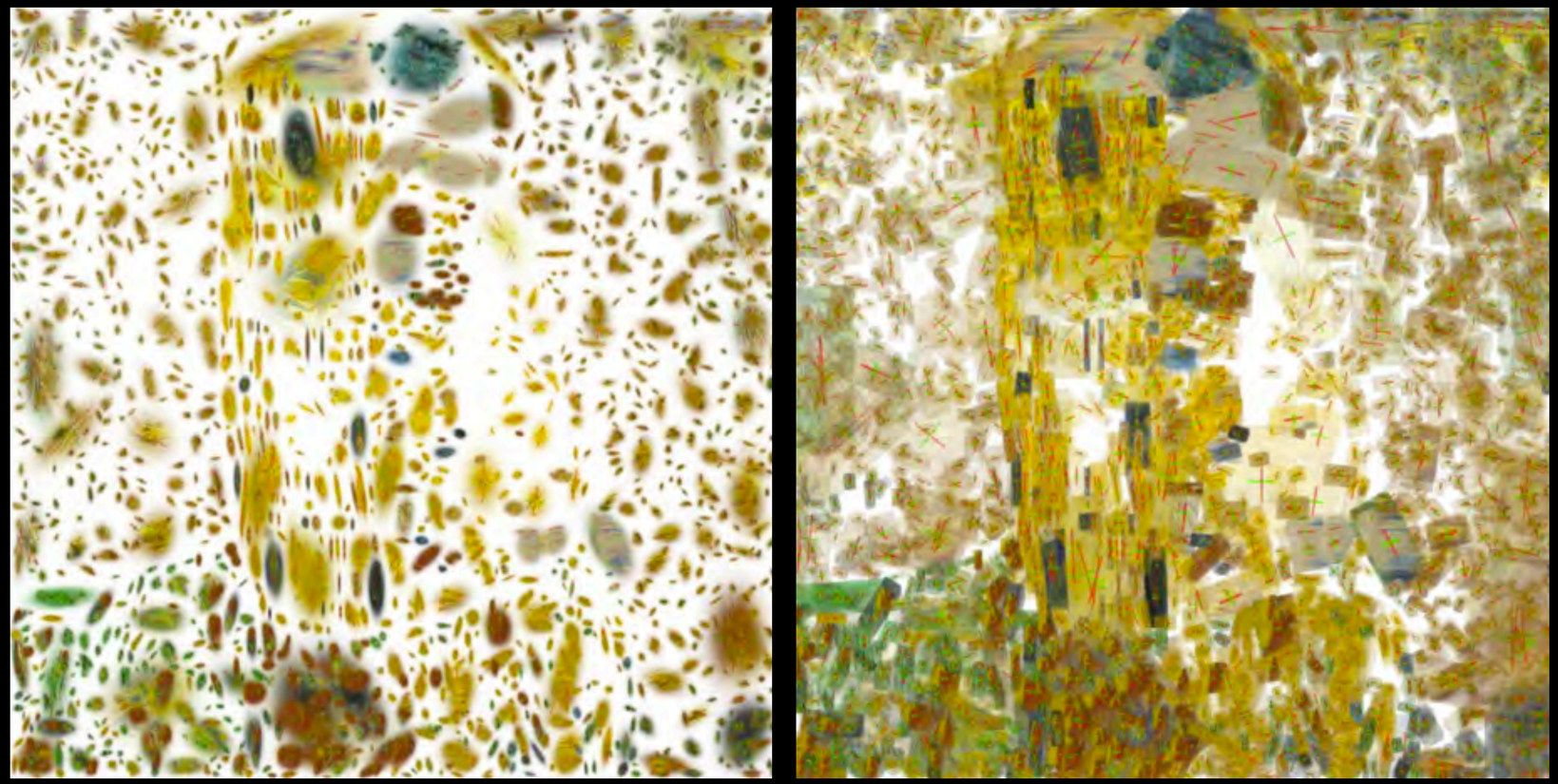
Discrete Parameters

- Spatial blending
- Temporal blending
- Motion tracking

Continuous Parameters

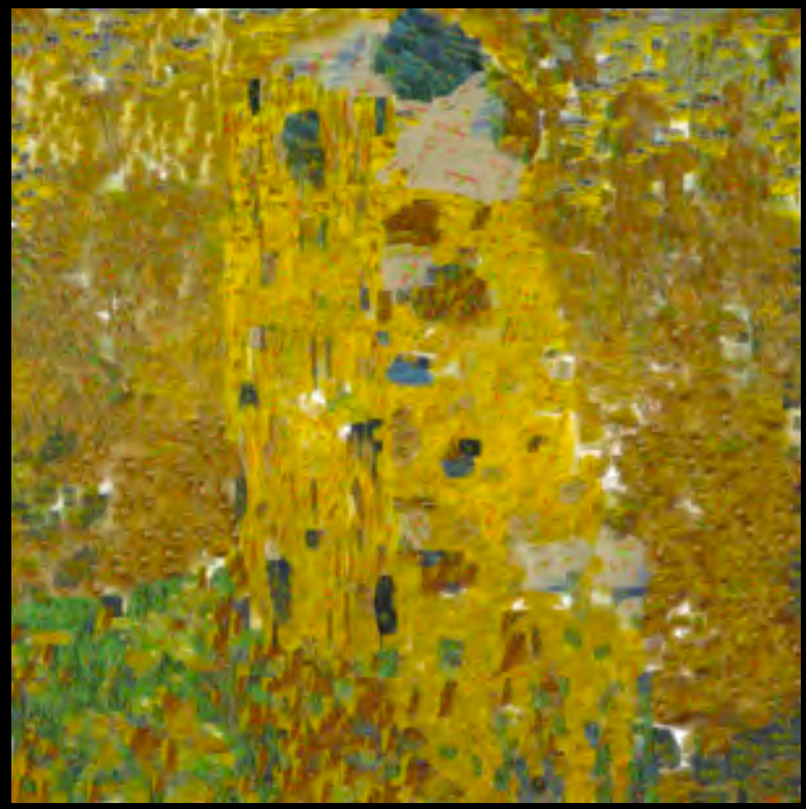
- Timesteps
- Minimum region size
- Maximum region size
- Blending radius

Spatial Blending

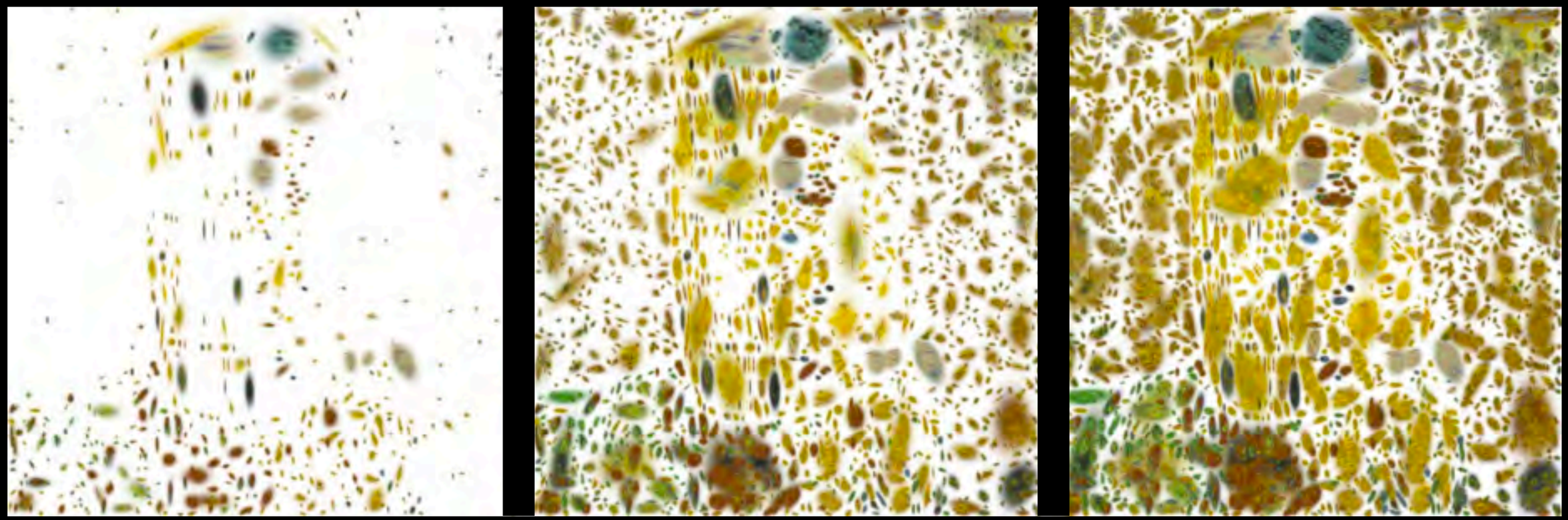


Temporal Blending

Temporal Blending



Timesteps

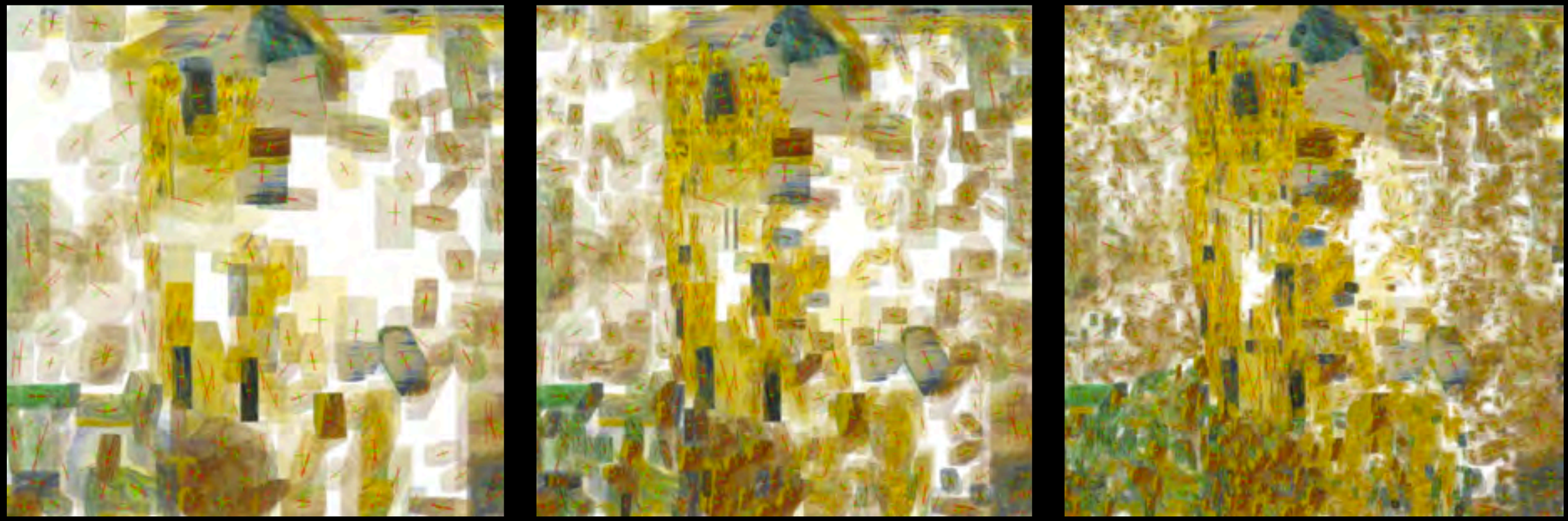


Increasing timesteps

=

Denser layers, More expressive

Minimum Size

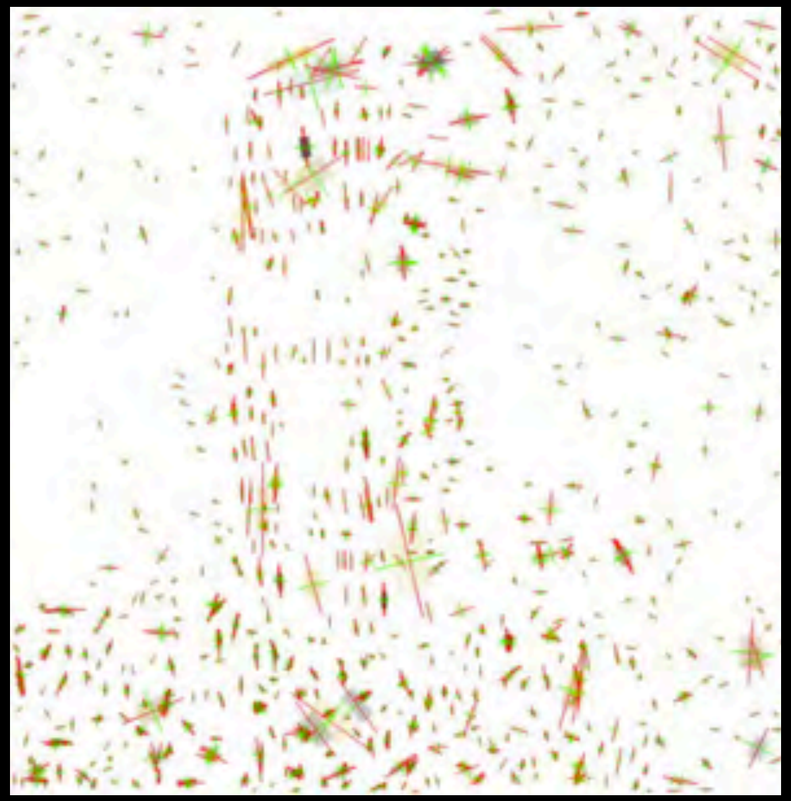


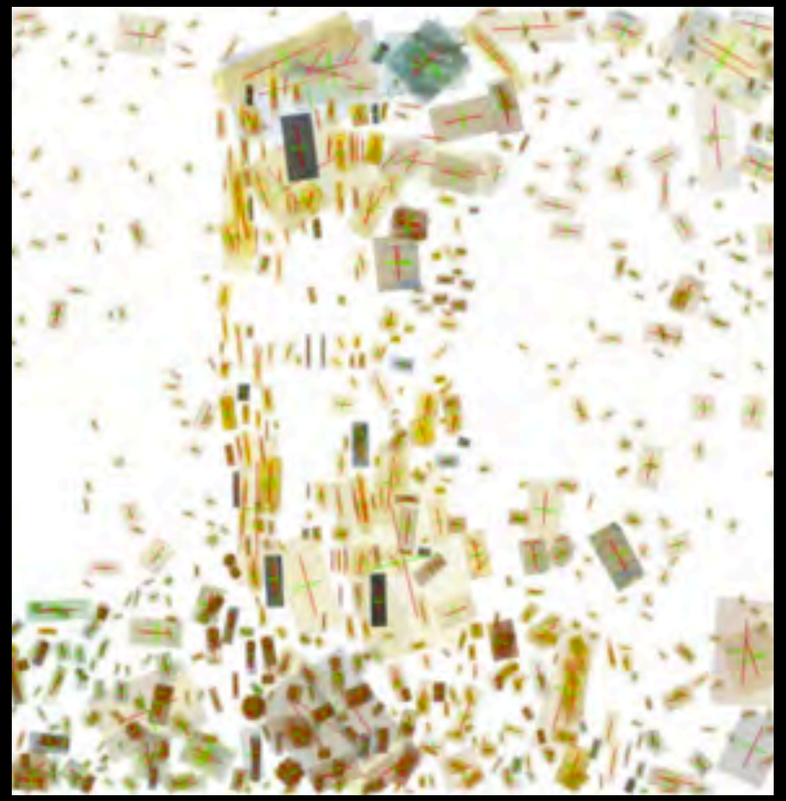
Decreasing minimum size

=

Finer brush strokes

Blending Radius





Increasing radius

=

More of source texture

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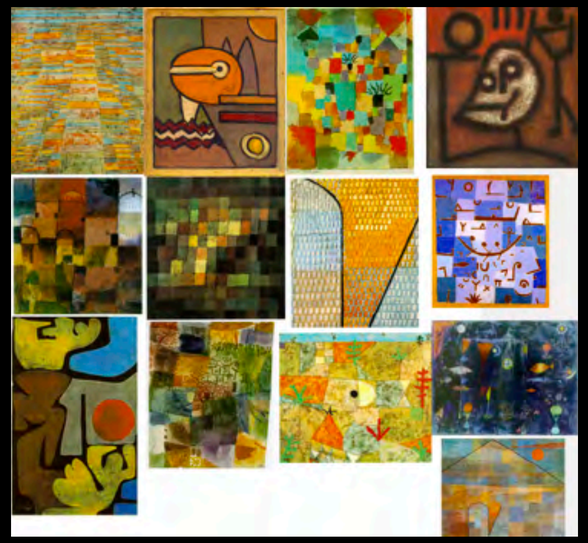
Target Image

Corpus



Synthesis

Target Image

Corpus

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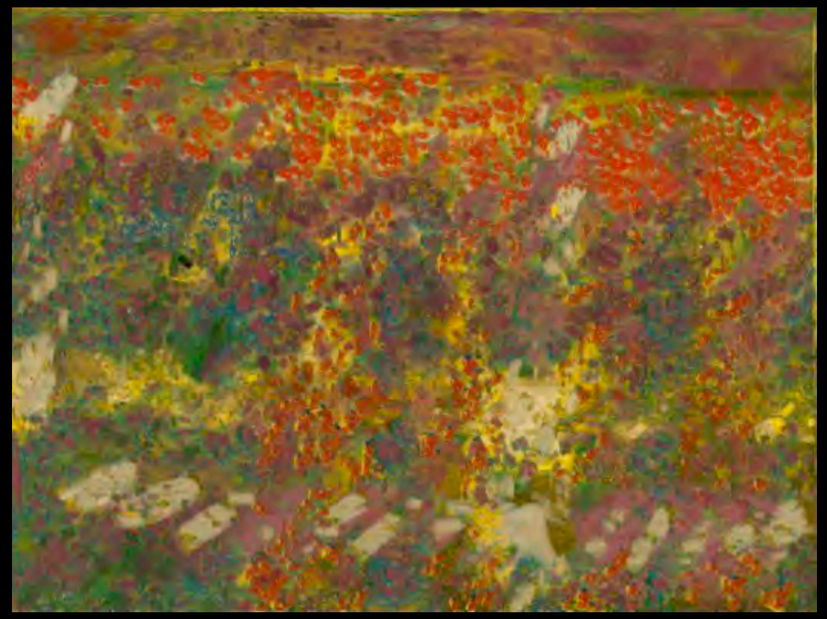

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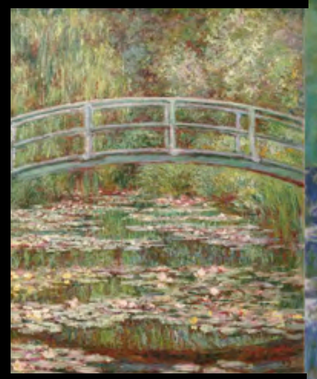

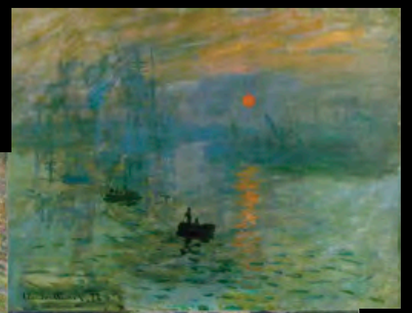

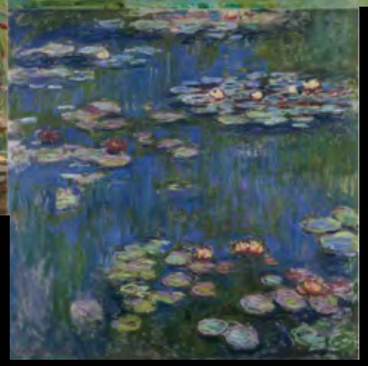

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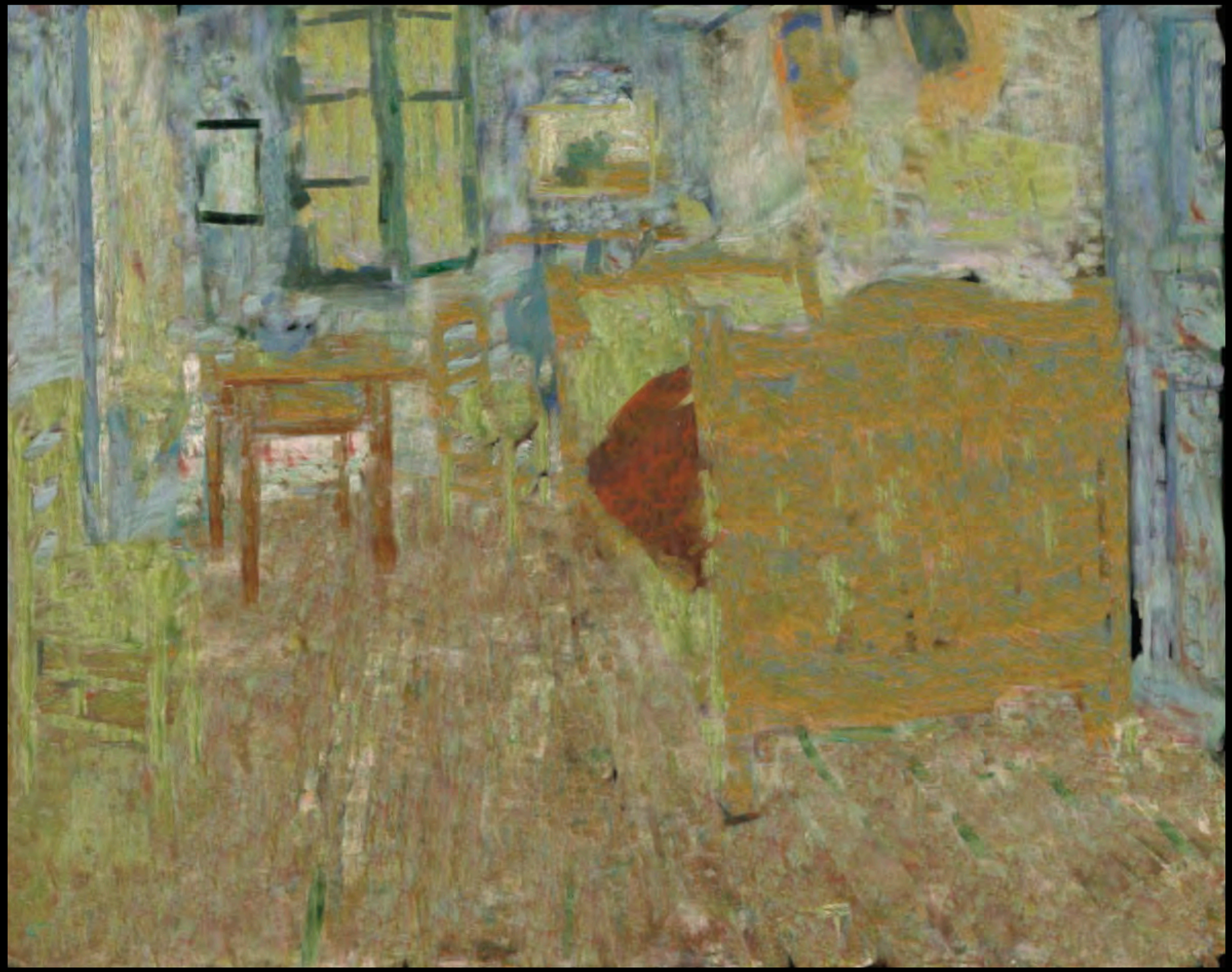

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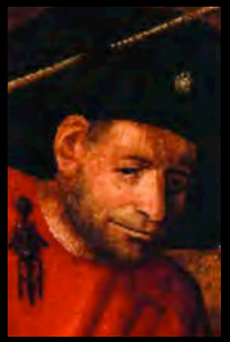

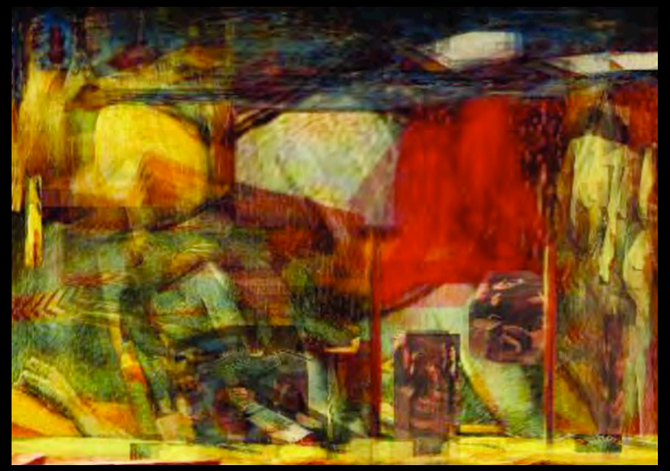

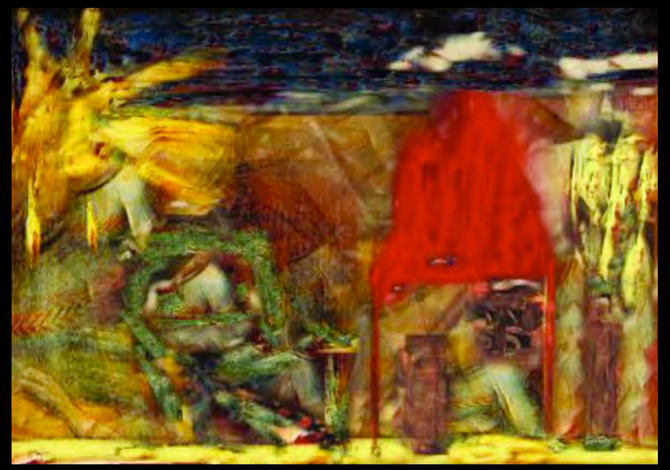

지금부터
감 대사지 가

Outline

- CBVS Framework
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  - Augmented Reality Hallucinations
  - PhotoSynthesizer (iOS app)
- Conclusion

Memory Mosaicing

- Dynamic target (movie or webcam)
- Aggregate corpus over time using target, retaining only most recent N objects
- Only allow learning of objects with distance greater than threshold

Live demo

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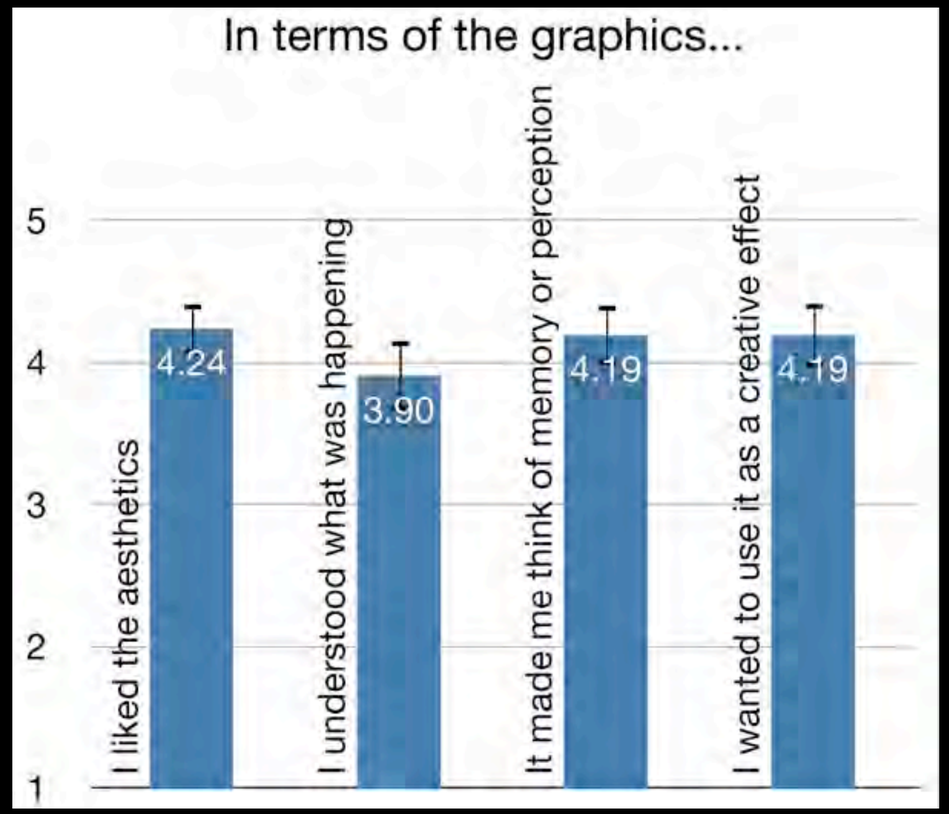
Augmented Reality Hallucinations



- Memory Mosaicing
- Uses Augmented Reality headset
- Exhibited during the Victoria & Albert Museum's Digital Design Weekend co-located during the London Design Festival, 15,000 participants
- Short questionnaire for participants rating their experience (21 participants only)

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PhotoSynthesizer

- Free iOS app allows user to synthesize target image
- No interaction besides selecting target and corpus
- Reveals synthesis process as painting regions over time
- Reached Top 50 app in Photo & Video in many countries

PhotoSynthesizer

PhotoSynthesizer

Store	Price	Compatibility	Publisher
iTunes	Free	Universal	Parag K Mital

Ranks | Highest Ranks

	Overall	Photo and Video
# of countries - rank 10 reached	0	1
# of countries - rank 100 reached	0	10
# of countries - rank 500 reached	1	26
# of countries - rank 1000 reached	1	26
Country		
Qatar	**397** Nov 3, 2012	**19** Nov 3, 2012
Pakistan	-	**10** Aug 25, 2012
Bermuda	-	**26** Apr 22, 2013
Argentina	-	**39** Aug 23, 2012
Philippines	-	**41** Sep 7, 2012
Belgium	-	**43** Sep 12, 2012
United Kingdom	-	**44** Sep 3, 2012
United States	-	**46** Aug 31, 2012
Spain	-	**51** Sep 12, 2012
Ireland	-	**64** Aug 23, 2012
India	-	**123** Aug 26, 2012
France	-	**128** Aug 24, 2012
Hungary	-	**143** Aug 12, 2013

Live demo

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Conclusion

- Simple shape representation affords range of stylizations and a range of non/real-time applications
- Expressive control in a few parameters
- Future?
  - Better method of evaluation
  - Better metrics for shape description
  - Better temporal coherence