Computer Vision for Visual Effects

CVFX 2015

Internet-based Inpainting

- **Get Out of my Picture! Internet-based Inpainting**.
  - Oliver Whyte, Josef Sivic, and Andrew Zisserman
  - BMVC 2009

Idea

- Using other photos of the same scene from the Internet to do inpainting

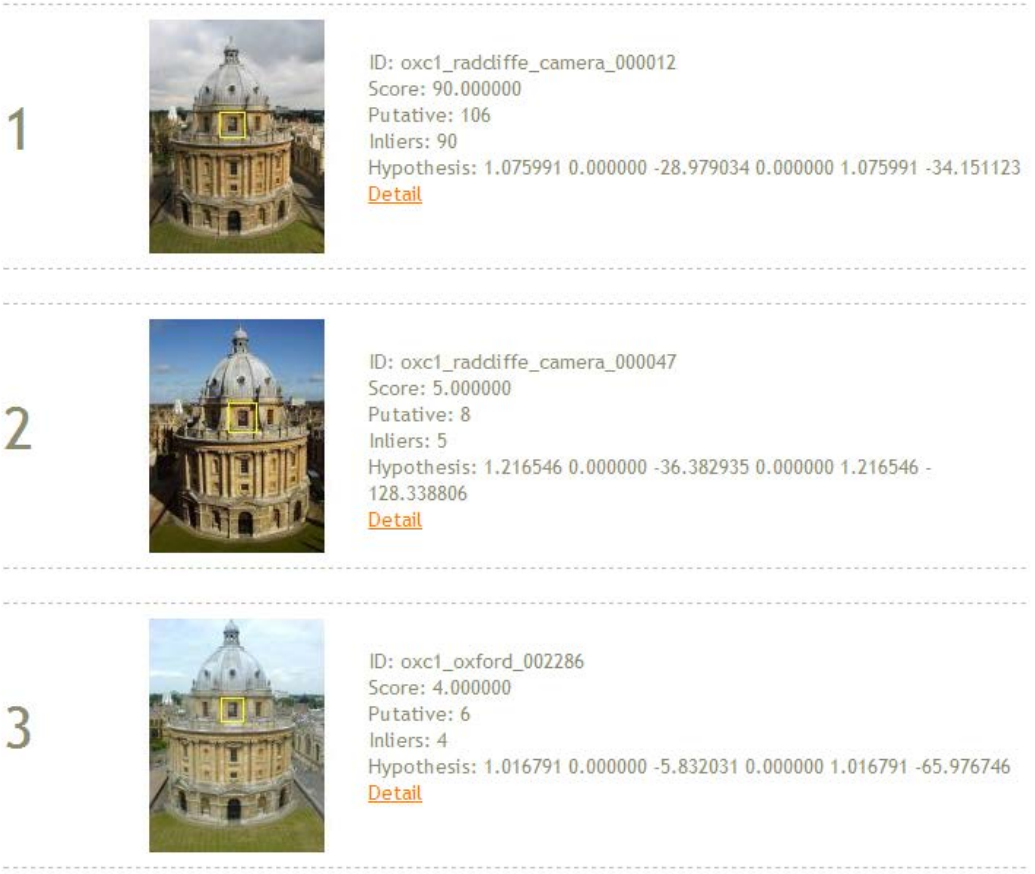
Related Work

- **Scene Completion Using Millions of Photographs**
  - Hays and Efros
  - SIGGRAPH 2007
  - http://graphics.cs.cmu.edu/projects/scene-completion/

  - Not the same scene but semantically similar scenes

Retrieving Oracle Images

- Oxford Building Search
  - http://www.robots.ox.ac.uk/~vgg/research/oxbuildings/index.html



Geometric Registration

- Homography
  - Outdoor urban scenes are approximately planar
    - » RANSAC
    - » 5000-15000 HarrisAffine & SIFT interest points per image
    - » SIFT descriptors

Geometric Registration

- Multiple homographies
  - Run RANSAC, remove inliers, run RANSAC again, …
- User Registration
  - Semi-automatic ground plane registration

Photometric Registration

- Gradient-domain editing
  - Poisson blending

- Correction: taking median over the *well-registered* pixels of the ratio of gradient magnitudes between the query image and the registered oracle for each color channel

$$\text{median}_{\mathbf{p}} \left(\frac{\|\nabla I^c_{\text{query}}(\mathbf{p})\|}{\|\nabla I^c_{\text{oracle}}(\mathbf{p})\|} \right)$$

Well Registered Pixels

- Normalized cross-correlation (NCC) between the 15x15 patch around each pixel in the query with the corresponding 15x15 patch in the transformed oracle

- MRF: data term linear with NCC scores, Potts potential
  - Solved by graph-cuts

Grouping Homographies

Combining Multiple Proposals

Formulated as a labeling problem

$$E(\mathbf{L}) = \sum_{\mathbf{p}\in\mathcal{V}} E_1(\mathbf{p}, L_\mathbf{p}) + \sum_{(\mathbf{p},\mathbf{q})\in\mathcal{E}} E_2(\mathbf{p}, \mathbf{q}, L_\mathbf{p}, L_\mathbf{q})$$

can be larger than the target region mask

$$E_1(\mathbf{p}, L_\mathbf{p}) = k_{\text{query}}\overline{M}(\mathbf{p})\|\mathbf{I}_{L_\mathbf{p}}(\mathbf{p}) - \mathbf{I}_{\text{query}}(\mathbf{p})\| + k_{\text{median}}M(\mathbf{p})\|\mathbf{I}_{L_\mathbf{p}}(\mathbf{p}) - \mathbf{I}_{\text{median}(G(L_\mathbf{p}))}(\mathbf{p})\|$$

label of proposal

target region mask

reconstructed by Poisson blending

If p is not inside the target region the corresponding pixel from the image of the chosen label should be consistent with p.

Combining Multiple Proposals

Formulated as a labeling problem

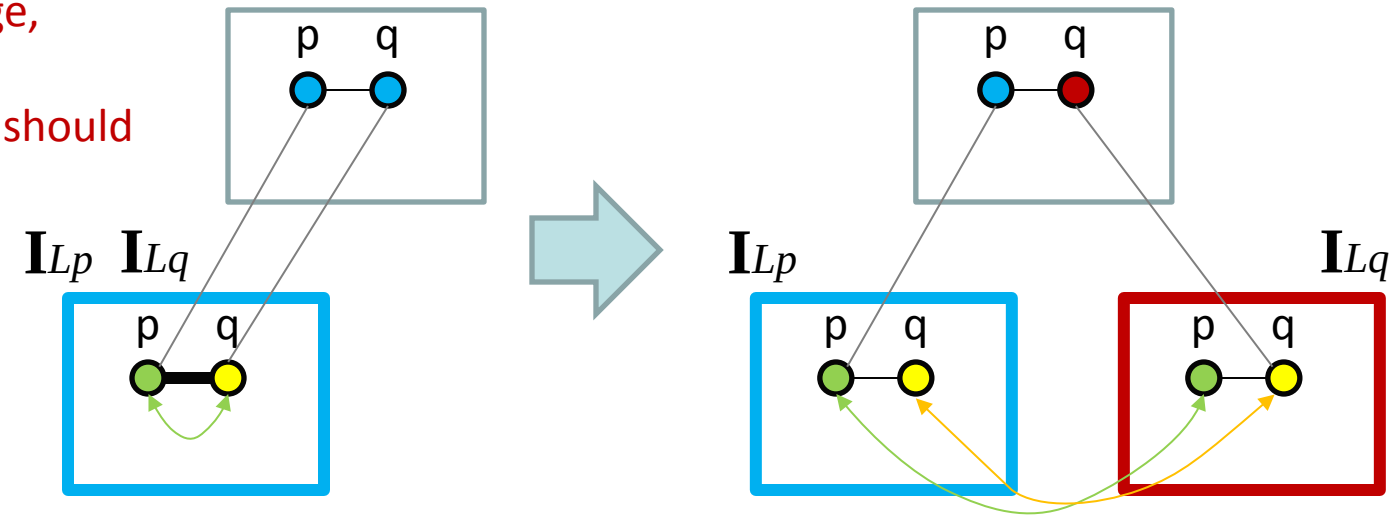
$$E(\mathbf{L}) = \sum_{\mathbf{p}\in\mathcal{V}} E_1(\mathbf{p}, L_\mathbf{p}) + \sum_{(\mathbf{p},\mathbf{q})\in\mathcal{E}} E_2(\mathbf{p}, \mathbf{q}, L_\mathbf{p}, L_\mathbf{q})$$

$E_2 = 0$ if $L_\mathbf{p} = L_\mathbf{q}$, and otherwise

$$E_2(\mathbf{p}, \mathbf{q}, L_\mathbf{p}, L_\mathbf{q}) = k_{\text{grad}} \left(\left\| \nabla \mathbf{I}_{L_\mathbf{p}}(\mathbf{p}) - \nabla \mathbf{I}_{L_\mathbf{q}}(\mathbf{p}) \right\| + \left\| \nabla \mathbf{I}_{L_\mathbf{p}}(\mathbf{q}) - \nabla \mathbf{I}_{L_\mathbf{q}}(\mathbf{q}) \right\| \right)$$

gradient in all color channels

If the difference of gradients is large, then assigning different labels should be penalized.



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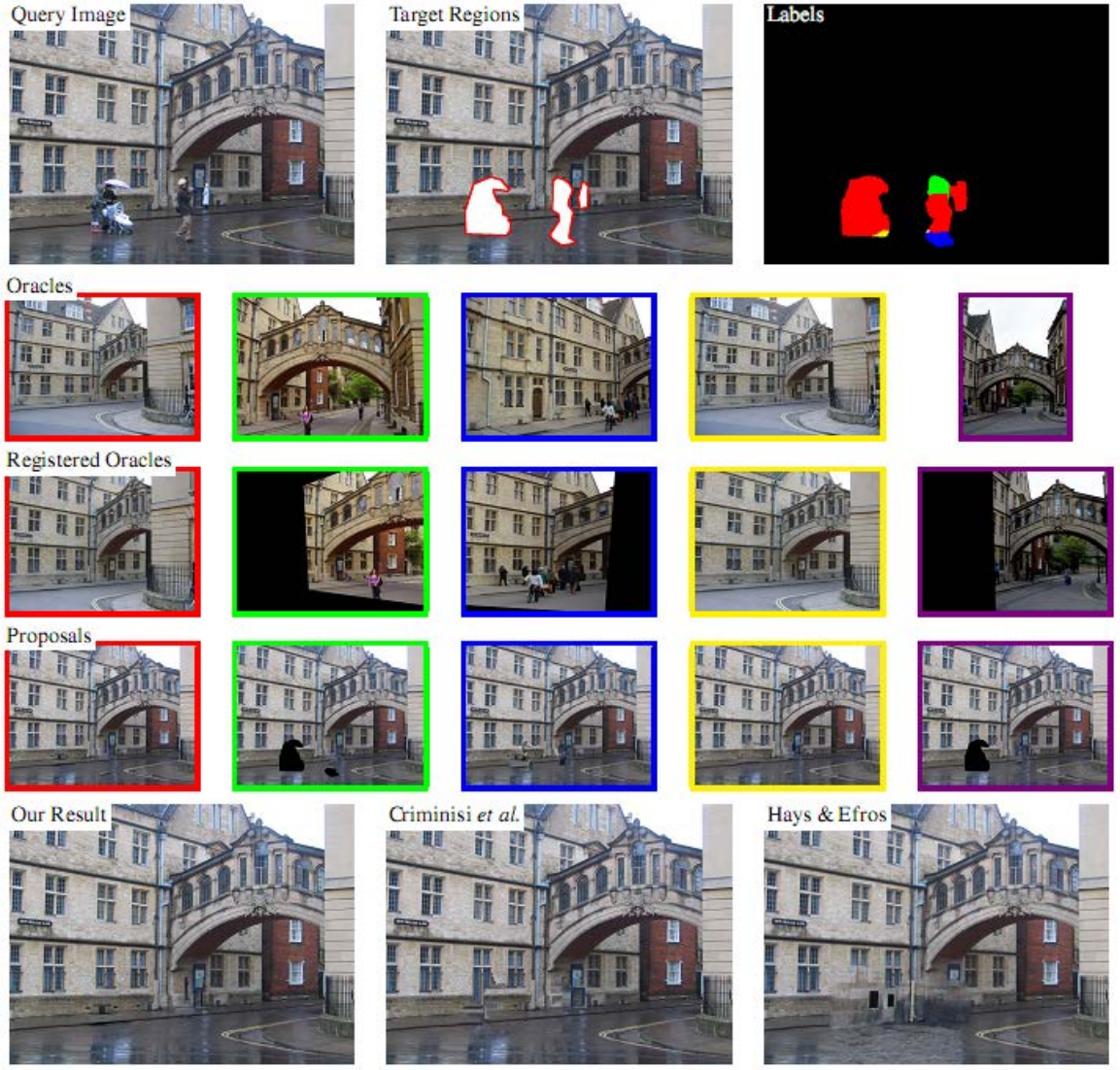
$$E_2(\mathbf{p}, \mathbf{q}, L_\mathbf{p}, L_\mathbf{q}) = k_{\text{grad}}\left(\left\|\nabla\mathbf{I}_{L_\mathbf{p}}(\mathbf{p}) - \nabla\mathbf{I}_{L_\mathbf{q}}(\mathbf{p})\right\| + \left\|\nabla\mathbf{I}_{L_\mathbf{p}}(\mathbf{q}) - \nabla\mathbf{I}_{L_\mathbf{q}}(\mathbf{q})\right\|\right)$$

MRF, solved by tree-reweight belief propagation

Combining Multiple Proposals



Results

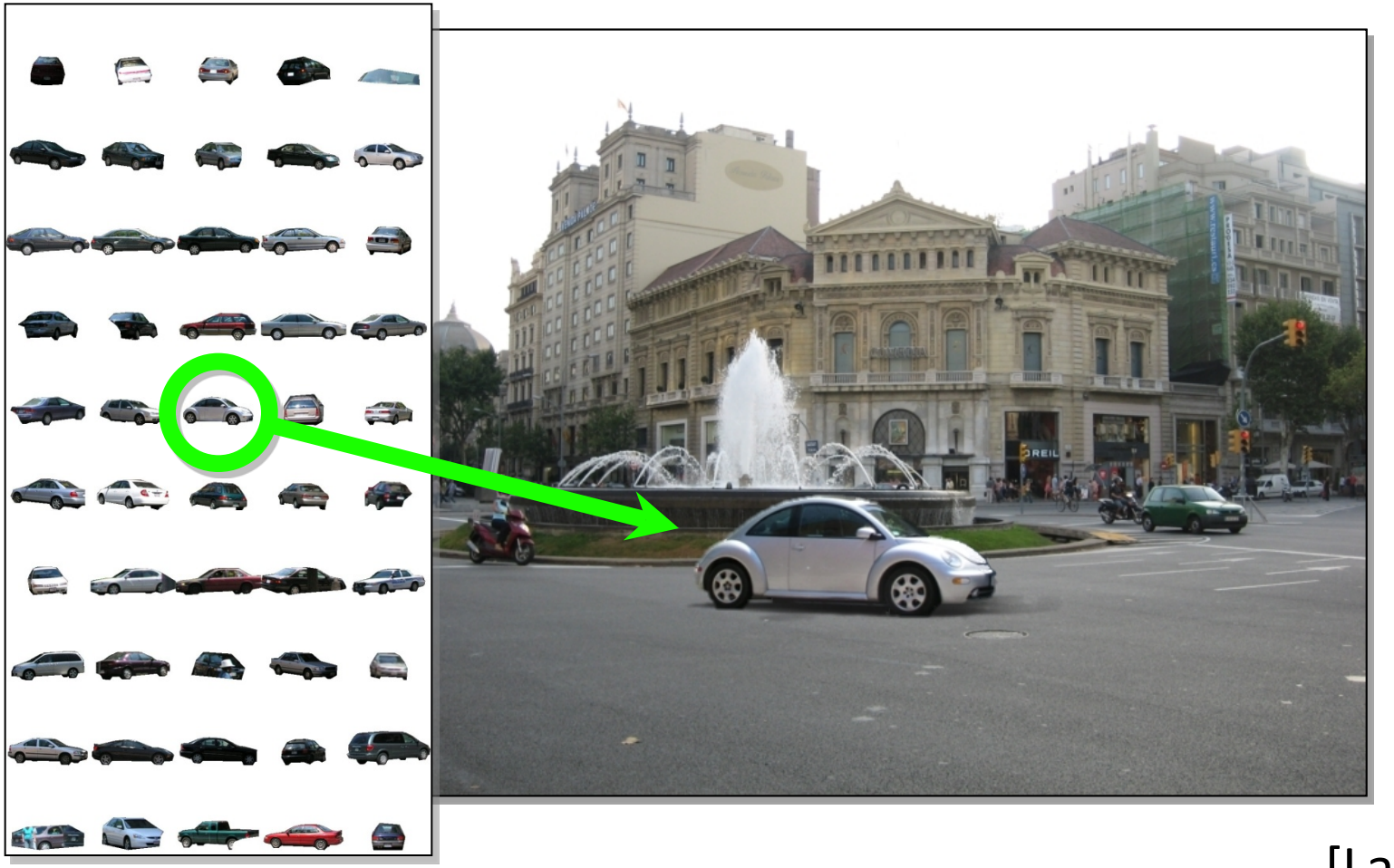
Oracles

Editing with Databases

- Image editing with image databases
  - *Photo Clip Art*
    - Lalonde *et al*., SIGGRAPH 2007
  - *Content Based Image Synthesis*
    - Diakopoulos *et al*., CIVR 2004

The Use of Data

- Insert **SOME** object: much easier!



[Lalonde *et al.*]

Photo Clip Art

[Lalonde *et al.*]

The Google model

Database

Query

Sort the objects

Results

Result: Street Accident

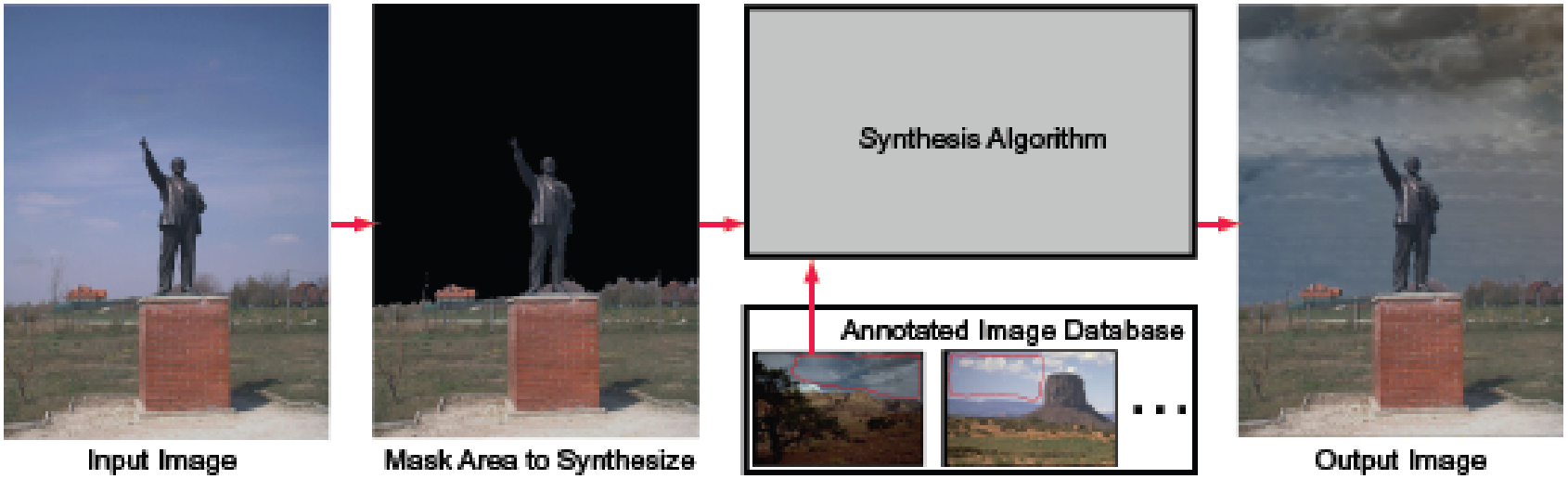
[Lalonde *et al*.]

Result: Alley

[Lalonde *et al*.]

Content Based Image Synthesis

- Create a database of imagery which has regions annotated with semantic labels
- Content based image retrieval + texture synthesis

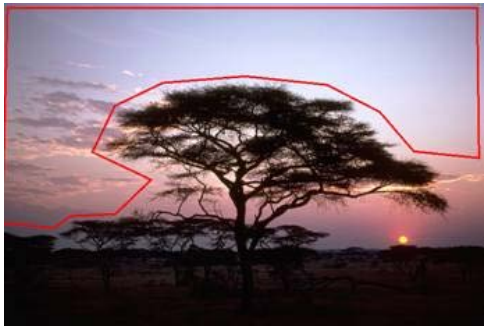


[Diakopoulos *et al.*]

Content Based Image Synthesis



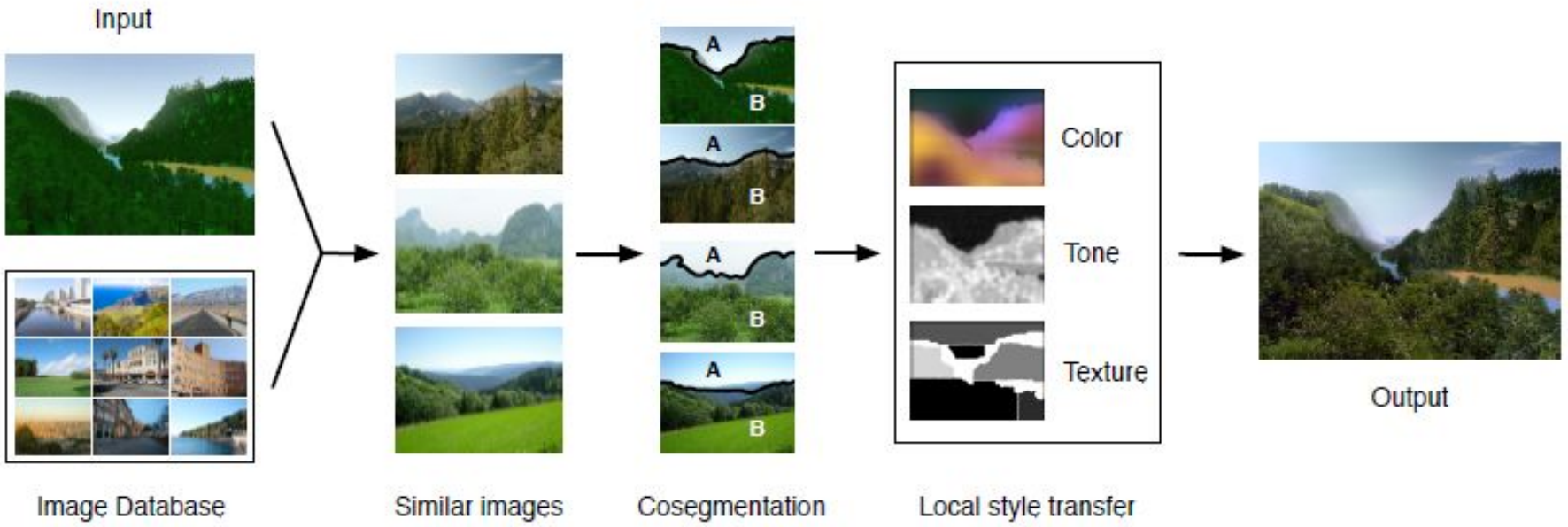





[Diakopoulos *et al.*]

CG2Real

- "CG2Real: Improving the Realism of Computer Generated Images using a Large Collection of Photographs," Johnson *et al*., TVCG 2010.



ShadowDraw

- "ShadowDraw: Real-Time User Guidance for Freehand Drawing," Lee *et al*., SIGGRAPH 2011.