



PHOTO STITCHING AND BLENDING

Using SIFT, RANSAC, Laplacian Pyramids

MAIN REFERENCES

- PanoramaImageStitching - Yupan Huang
  https://github.com/HYPJUDY/panorama-image-stitching
- OpenCV panorama stitching - Adrian Rosebrock
  https://www.pyimagesearch.com/2016/01/11/opencv-panorama-stitching/
- Referenced Paper: Automatic Panoramic Image Stitching using Invariant Features - Matthew Brown and David G. Lowe
  http://matthewalunbrown.com/papers/ijcv2007.pdf

PROBLEM DEFINITION

- Take as input two or more photos of the same view.
- Find overlapping regions and stitch the regions after aligning and warping as needed.
- Clean up the output to minimize visibility of the seams and differences in color.

IMPLEMENTATION

- Create an adjacency list and Boolean table for the input photos
- Extract SIFT features for each photo
- Choose the center image, in the current version a particular index, as the first incomplete stitch and add to work list
- Repeat until no photos left
  - Pop first index off the work list
  - For each adjacent photo in the adjacency list
    - Insert the index to the work list
    - Extract SIFT features for the last stitch
    - Compute Homography between the last stitch and the adjacent photo using RANSAC
    - Using Homography matrix, find the output dimensions and warp the adjacent photo into place
    - Blend the last stitch and the warped adjacent photo to get the new stitch
- Remove black regions from the stitched image to get the final output Panorama

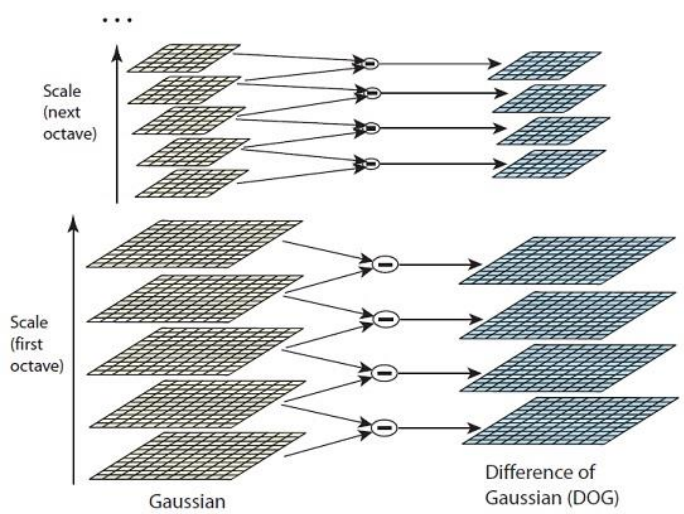
SIFT – SCALE INVARIANT FEATURE TRANSFORM

- Create Scale Spaces
  - Repeatedly apply Gaussian blur to the original image.
    Each set of the original image and progressively blurred images together form an octave
  - Resize by the original half and generate another octave
  - The author of the SIFT paper suggests four levels of octaves

$$L(x, y, \sigma) = G(x, y, \sigma) * I(x, y)$$

$$G(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2}$$

- Construct LoG Approximations
  - Difference of Gaussian, ie. pairs of consecutive images in an octave are subtracted, used to get Laplacian of Gaussians then used to find features

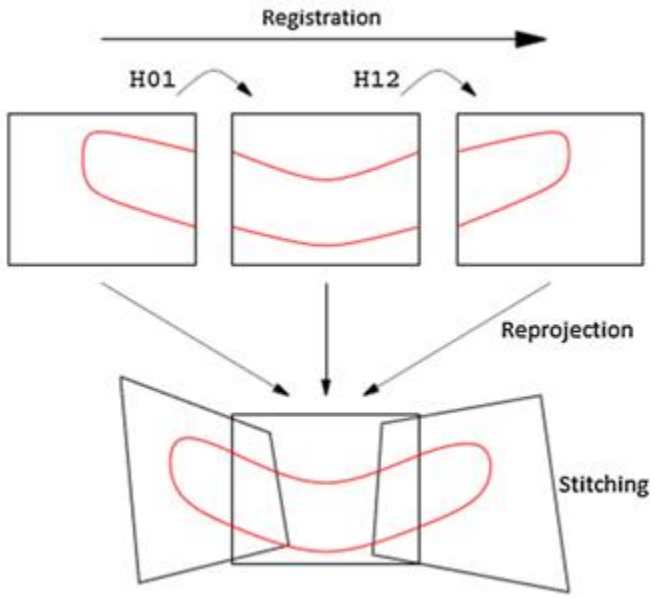


SIFT (CONTINUED)

- Key points are calculated using maxima and minima between different Gaussian scales
- Low contrast and edges which are bad key points are removed using LoG
- Assign orientation to the key points using gradients from the Gaussian scales
- Generate SIFT features each a 128 dimension representing 16x16 window for that feature

HOMOGRAPHY

RANSAC (Random Sample Consensus) is then used to calculate the Homography between two photos to project onto a common plane



LAPLACIAN PYRAMID BLENDING

- Create the Gaussian Pyramid by consecutively applying Gaussian blur and resizing to half its dimensions.
- Construct the Laplacian Pyramid by doubling the smaller image and then subtracting from former level. $L_i=G_i$-expand(G_i+1)
- Create Blend Laplacian Pyramid by applying mask between two images to be stitched
- By reversing the Laplacian Pyramid, reconstruct a blended Gaussian Pyramid. $G_i=L_i+$expand(G_i+1) and G_0 is the final stitch.

Applying cylindrical warping to the input creates more uniform detail in the final output by reducing horizontal distortion. Ideally we use camera parameters for the cylindrical projection.

THANK YOU