

# Content-Sensitive Superpixels Based on Adaptive Regrowth

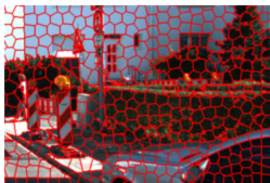
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25th International Conference On Pattern Recognition

# Superpixel

- Meaningful atomic regions that consist of image pixels
- Reduce the complexity of subsequent image processing tasks



Superpixels

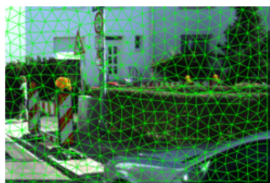


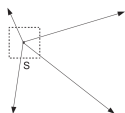
Image graph

- Segmentation
- Stereo
- Optical flow
- Tracking

# Simple Linear Iterative Clustering (SLIC)

[Achanta et al, "SLIC Superpixels Compared to State-of-the-Art Superpixel Methods," *PAMI* 2012]

- Chose centroids on a square grid
- Performs k-means clustering on the image plane
- Limit the search space of each cluster center



Standard k-means  
searches the entire image



SLIC searches a limited  
region

## Challenge

When many objects appear in the local regions, uniform superpixels produced by SLIC can cause under-segmentation.

# Content-Sensitive Superpixels

[Liu et al, "Manifold SLIC: A Fast Method to Compute Content-Sensitive Superpixels," *CVPR* 2016]

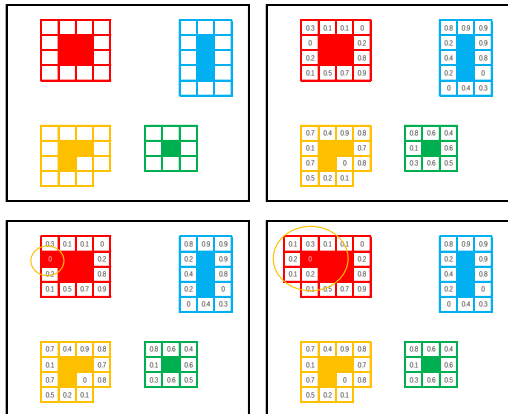
- Effectively capture the non-homogenous feature in image
- Small superpixels in content-dense regions
- Large superpixels in content-sparse regions

## Challenge

- inefficient
- Repeat computation in content-dense regions

- Boundary Evolution
- Region Seed
- Boundary Constraint
- Regrowth and Merging

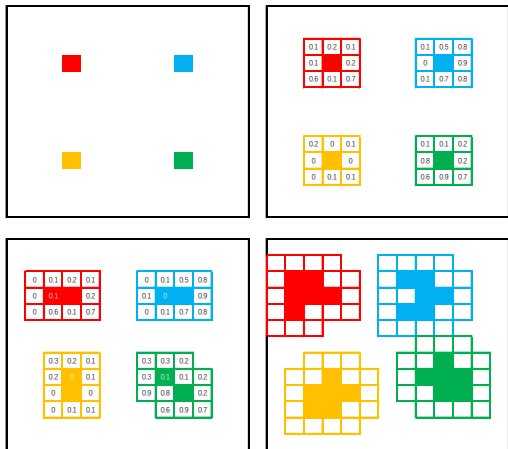
# Boundary Evolution



- 1 Select unlabeled pixels around labeled regions
- 2 For each labeled regions, compute distance to unlabeled neighbors
- 3 Label the pixel with the minimum distance
- 4 Compute distance to the neighbors of the newly labeled pixel
- 5 Repeat 3-4 until all pixels are labeled

# Region Seed

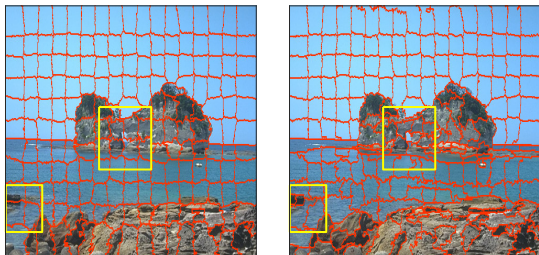
Small region is used as the seed of superpixel for catching a stable information about an object.



- 1 Sample pixel seeds on regular grids
- 2 Compute color distance between labeled and unlabeled pixels
- 3 Select the pixel with the minimum distance. If the pixel satisfies condition, label the pixel
- 4 Compute distance to the neighbors of the newly labeled pixel
- 5 Repeat 3-4 until the sizes of seeds reach the expected value

# Boundary Constraint

- Detect object boundaries in image
- Prevents superpixels from crossing object boundaries

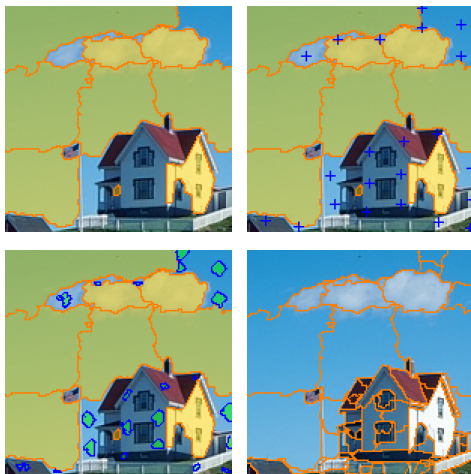


- Reduce under-segmentation error
- Make some pixels unlabeled



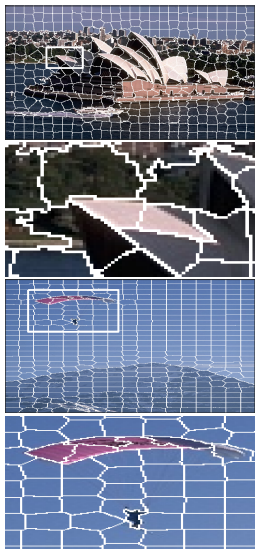
# Regrowth and Merging

- Produce new superpixels in the unlabeled regions
- Reduce the number of the superpixels

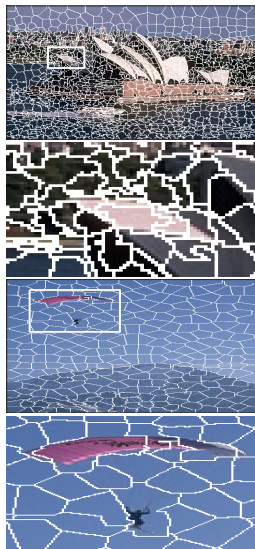


- 1 Place the pixel seeds in the unlabeled regions
- 2 Generate the region seeds
- 3 Expand the boundaries of region seeds to form superpixels under the boundary constraint condition
- 4 Repeat the above steps until all pixels are assigned to superpixels
- 5 Apply region merging method to reduce the number of superpixels to the desired one

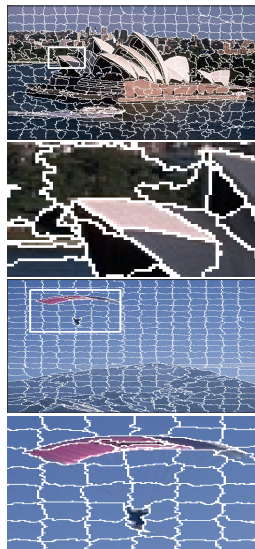
# Visual Comparison



SLIC

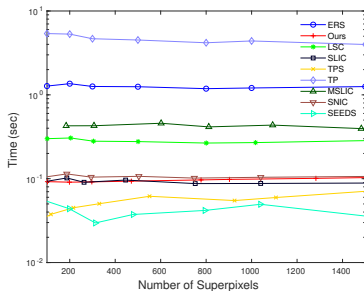
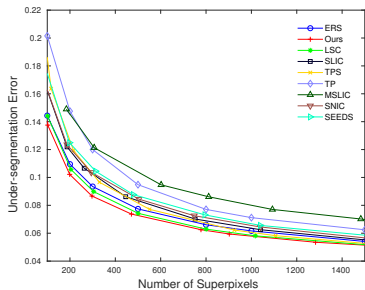
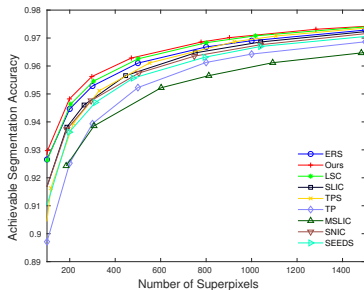
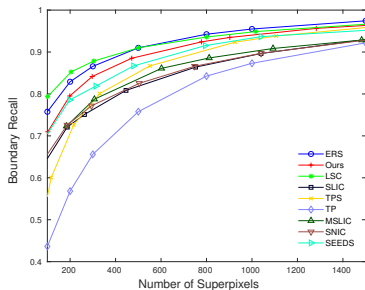


MSLIC



Ours

# Performance Evaluation



# Conclusion

- A efficient method to produce the content-sensitive superpixels
- Adopt boundary constraint to ensure semantic consistency
- Generates more superpixels to capture small objects in content-dense regions
- Future work
  - Track superpixels in two frames
  - Optical flow