Fast Superpixels for Video Analysis

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1. Background

- Instead of analyzing video using tens of thousands of pixels in each frame, would like to restrict analysis to about 1000 superpixels in each frame:

60,000 pixels

1200 superpixels

- Popular existing superpixel algorithms use 2D, region-based approaches that are too slow for real-time video analysis
- In fact, superpixels can be computed using 1D dynamic programming approaches that are much faster
  - *Seam carving* (Avidan & Shamir 2007), *superpixel lattices* (Moore et. al 2008), and *PathFinder* (this poster) are all examples of the 1D dynamic programming approach

2. Main result

our 1D approach is:

- 3% less accurate
- 30-40 times faster

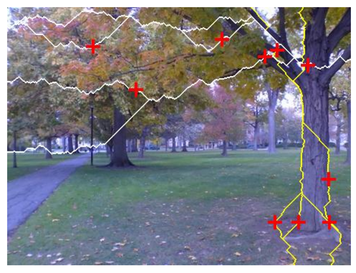
. . . than fastest known 2D approach

Therefore, 1D superpixel approaches should be attractive for video analysis

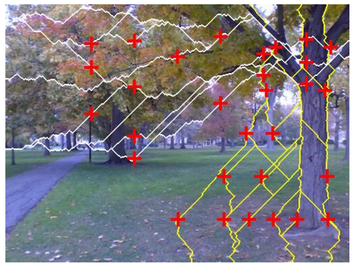
3. PathFinder: example of a 1D approach to superpixels

1. Compute edge strengths from a cheap Sobel-like operator
2. Build approximately-vertical paths that follow strong edges. While more paths are needed:
   - 2.1 Choose a seed point at a strong edge, not near an existing path
   - 2.2 Grow the approximately vertical path with maximum total edge strength from seed
     - very cheap via dynamic programming
     - restrict path to deviate from vertical by at most 45°
3. Repeat step 2 for horizontal paths
4. The resulting deformed grid defines the boundaries of the superpixels

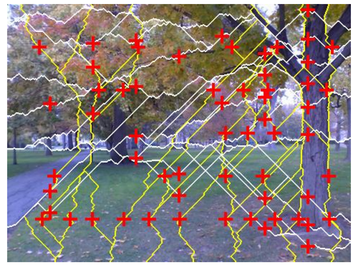
1 path



5 paths



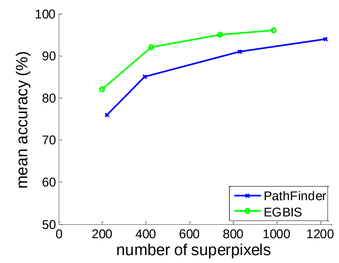
15 paths

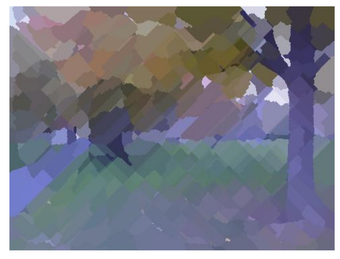


30 paths

4. Results:

- Compare with the fastest known 2D approach: “Efficient Graph-Based Image Segmentation” (EGBIS), Felzenszwalb & Huttenlocher 2004.
- Assess accuracy using “mean accuracy” of Moore et. al 2008, which compares with human segmentations
- PathFinder is about 3% less accurate:





PathFinder

EGBIS

- PathFinder is 30-40 times faster: