Restricted Coloring using Saliency-based Image Segmentation

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Figure 1: Original image and saliency map, Recursive K-means segmentation, CCL segmentation, CCL segmentation with overlaid edges

We describe two different methods of restricting the number of colors used to draw a certain image, while preserving detail in salient regions. In both methods, images are segmented based on saliency data, assigning larger regions to less salient areas of the image, and filling each region with its mean color.

DeCarlo and Santella [DeCarlo and Santella 2002] describe a method of stylization of photographs that creates pictures composed of large regions of color that vary in detail based on saliency measured by an eye tracker. They apply Mean Shift segmentation at multiple scales and assign each segmented region to a parent region at a coarser scale, based on area of overlap and distance in color space. This creates a segmentation tree which can then be pruned based on saliency to leave out detail in less salient regions. However, a region and its parent do not always overlap exactly, and coarse regions need to be smoothed because they are extracted from smaller scales.

In our first method, we remove those limitations by recursively segmenting the images using a K-Means with Connectivity Constraint (KMC) algorithm [Kompatsiaris and Strintzis]. We favored this algorithm because it tends to assign pixels within a close distance to the same group. Our recursive K-Means algorithm first assigns all the pixels into one parent region. Then for each region, run the KMC algorithm if the mean saliency of the region is less than a threshold and the maximum depth has not been reached (K more segments are created and pushed into the segment list). We define our distance metric to be the weighted sum of the distances in *LUV* color space, pixel location, and saliency.

In order to run K-Means on image sequences, we can segment the entire volume by considering a distance in time as well. To reduce computation we calculate the means on a scaled down volume, and later apply them to the full size sequence.

For saliency, we used both hand-drawn saliency maps and ones produced by the ”iLab Neuromorphic Vision C++ Toolkit” [Itti and Baldi].

In our second method, to allow for more cohesive regions, we also introduce a new image segmentation algorithm based on connected components labeling (CCL) of images [Rosenfeld and Pfaltz 1966], which assigns a different ID to every region of connected pixels which have the same value. We loosen that definition and assign a pixel to a region if its distance in color space from the mean of the current region is under a certain threshold. This threshold can be used to control the number of regions created (a smaller threshold will keep more of the detail). Each region is then filled with its mean color. The saliency map can also be used to vary the threshold across the image. The method is further improved by overlaying the result of applying a Canny edge detector over the image. The Canny edges increase contrast along important edges in the image, preventing regions from spanning across them.

The saliency map can also be used to overlay edges computed at different scale on top of the image. A Gaussian pyramid is constructed, and edges are computed at every scale using a Sobel filter. For each pixel in the final image we select a particular scale based on saliency, with less salient regions corresponding to coarser scale.

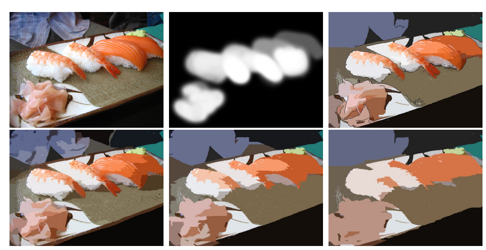

Figure 2: Top: original image, saliency map, and CCL segmented image using saliency map and Canny filter. Bottom: CCL segmented images using thresholds from 0.1 to 0.2.

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