

Merging Feature Vector based Image Segmentation

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Poster Abstract -- In this poster we show an effective Image Segmentation algorithm that is based on the K-means algorithm. Our research makes two key contributions: First, for the cluster assignment phase, while the K-means algorithm usually depends on just the distance or pixel intensity, we employ an Energy Function defined as a weighted sum of square differences related to multiple pixel and neighborhood characteristics. Second, we also added a Cluster Merging criterion, where clusters that are close together merge in order to form a new cluster. Our tests show that our two contributions over K-means algorithm display a more congruent segmentation when compared to other methods.

Index Terms --Image Segmentation, Unsupervised Learning, Feature Vectors, Cluster Merging.

Algorithm

- 1) Convert Input Image to Grayscale
- 2) Perform Histogram Equalization
- 3) Set Input parameters (**n,w,MT,C**)
 - a. **n**: number of iterations, **w**: vector weights, **MT**: Merging Threshold, **C**: number of initial clusters
- 4) **For** every Pixel in image **do**
 - a. **For** every Cluster in image **do**
 - i. Compute Energy Function (E.F.)
 - ii. Assign Pixel to corresponding minimum E.F. Cluster
- 5) Relocate Cluster centers (centroid method)
- 6) Check Merging Criterion
- 7) **Repeat** from step 4, for **n**

Energy Function

$$E(\bar{x}, \bar{C}) = \sqrt{\sum w_i \cdot (x_i - C_i)^2}$$

The Energy Function used is a modified Euclidean distance between two points, where weights have been added. However, pixel x and cluster C , each have 5 dimension feature vectors, rather than only x and y values, for position. These dimensions include: x position, y position, pixel intensity, horizontal Sobel operator, vertical Sobel operator.

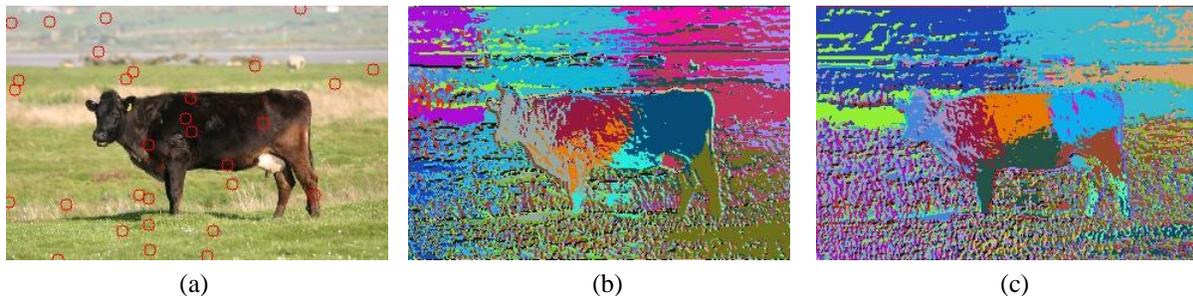


Fig 1. K-means algorithm with E.F. for image segmentation. (a) Initial image with 30 clusters. (b) First segmentation. (c) After 20 iterations result is shown. Result does not include Cluster Merging

Cluster Merging

When the segmentation process begins, clusters will re-locate themselves as the original K-means algorithm suggests. However, because our feature vector includes more than just position, there may be cases where cluster centers may be very close together. When cluster centers reach a threshold pixel distance, they are automatically merged, thus making the segmentation less confusing, and more consistent.

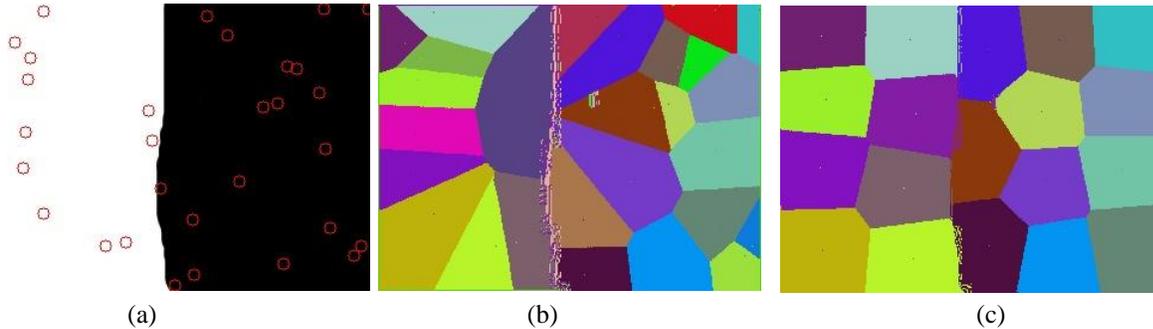


Fig 2. Cluster merging example. (a) Original image with randomized initial clusters (red). (b) Segmentation of image with 30 initial clusters. (c) Segmentation of image after adding the Cluster Merging step. The clusters reduce to 19.

Conclusions

While most state-of-the-art segmentation algorithms are closely related to image recognition techniques, which in their majority use computationally expensive probabilistic graphical models, the model we propose here is relatively simple and can be very effective on segmenting regions. In addition, most initial parameters such as number of iterations, weights, merging threshold and initial number of clusters can be easily adjusted. The latter can be very useful if one has the intention of performing various segmentations to detect consistent regions.

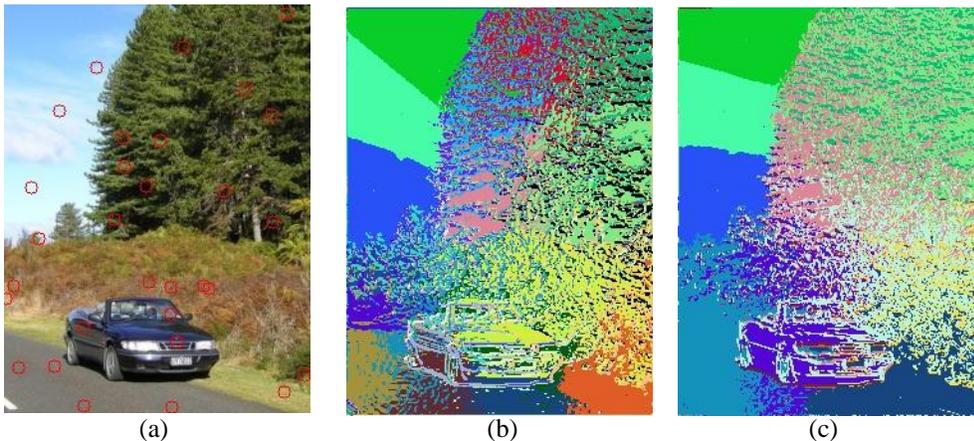


Fig 3. Energy Function and Cluster Merging segmentation (a) Initial Image with 30 clusters. (b) First Segmentation. (c) After 20 iterations result is shown. Result does include Cluster Merging.

References

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