Enver Bashirov 21203023

CS484 -1
Image Analysis
Homework #3

Introduction

This report explains an approach on image segmentation by the use of superpixels, Gabor Convolution, K-Means segmentation. 10 sample images are used in the analysis and their size is 768 by 512. One external image was also tested in order to be able make comparisons on different formats of images, which has 1080 by 1919 dimensions. Details about the results and algorithms are included in the rest of the report.

Project Overview

Since it contains a wide range of image analysis tools and because of it's ease of use, MATLAB was chosen to use as the implementation platform.

First thing done in following project path, superpixel segmentation's and Gabor convolution results are produced from raw images. Second, overall color feature vector and texture feature vector (Gabor convolution results) are computed using only the pixels in superpixel segmentation results. Also, separate color feature vector average is computed for all pixels in all images. Next, four vertical concatenation of matrices are produced from superpixel color vectors, texture vectors, and combination of color and texture vectors and finally, non-superpixel color vectors. And at last, these matrices are given to K-means algorithm which then results are applied to the initial images. Explanations about algorithms are given below.

Simple Linear Iterative Clustering (Superpixel Calculation): Two of the superpixel algorithms implementations have been used, SLIC () and SLIC0. SLIC0 algorithm is a zero compactness factor implementation. In both of them, 200 superpixel parameter was given and for the SLIC algorithm 15 compactness factor have been used. Compactness parameter can be defined as how similar a superpixel boundary will be to a rectangle.

I did not personally check the implementations of the SLIC algorithms but I can confirm that on some of the images, these algorithms produced oversegmentations. There were above 200 superpixel for some of the images.

Gabor Convolution: Gabor filter is main idea behind this algorithm. Given n orientation and m scale parameters, n time m results are produced. Orientation parameter defines the number of different angles and scale parameter defines the number of different scales will be used as Gabor filter.

K-Means: In simple terms, this algorithm finds the most similar clusters of values and pushes center point of the cluster from initial starting point to the true center of the cluster. Because of this approach, clustering is very accurate. The one that is used in the project is MATLAB implementation of K-Means algorithm. When given n by m array of values, the product is n by 1 array meaning that the all values of rows are considered as a point in two dimensions.

Results

This section gives explanation on how the results are obtained from the path of algorithms used.

GABOR CONVOLUTION

Gabor Texture Feature Calculation: Scale and orientations parameters are both 4. Rest of the parameters were set to default.

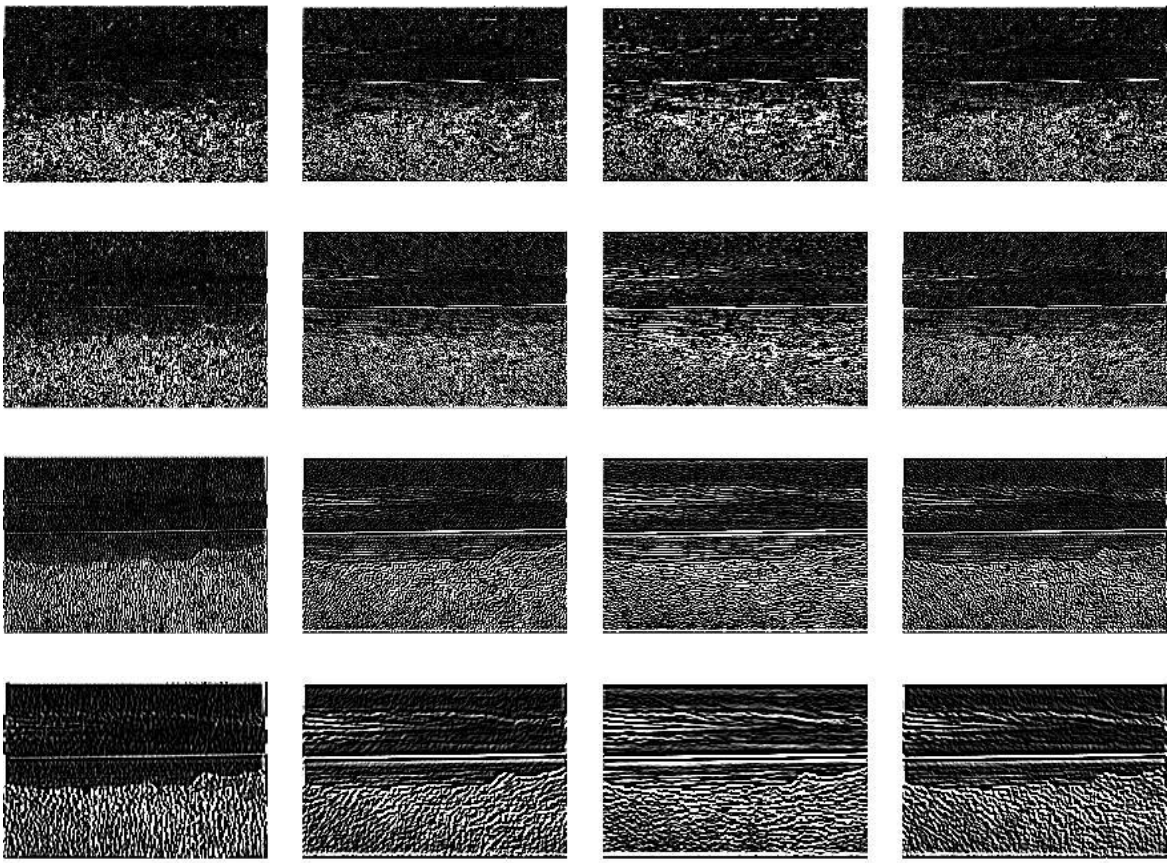

Figure 1: Gabor convolution results for 4 orientation and 4 scale images.

SLIC

The results of the RGB labeling K-means algorithm for different K parameter results are included below. Note that colors are only for distinguishing regions from each other.

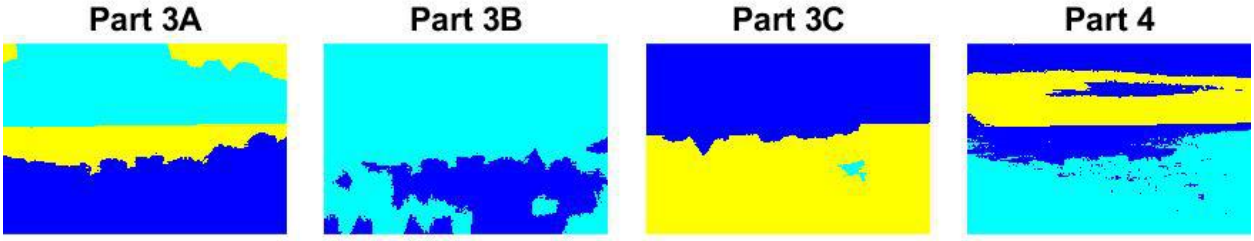

Figure 2: RGB labeling of K-means algorithm on SLIC feature vectors with parameter 3.

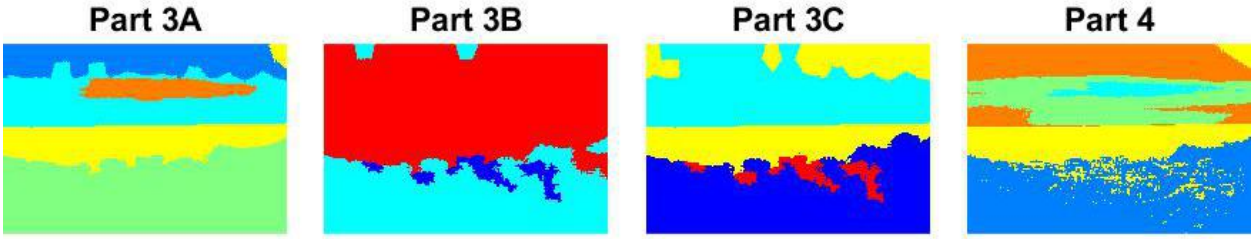

Figure 3: RGB labeling of K-means algorithm on SLIC feature vectors with parameter 5.

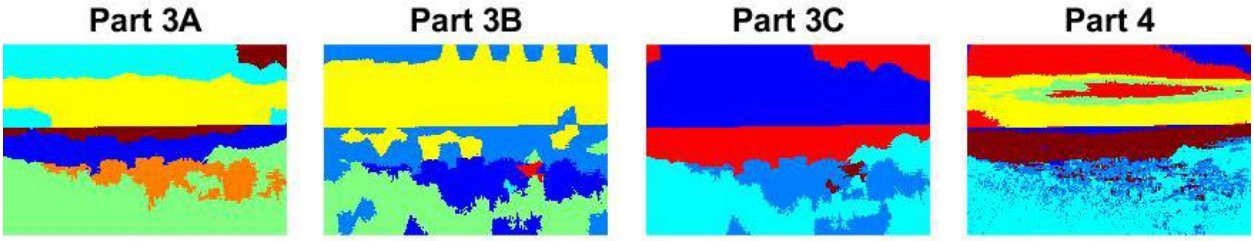

Figure 4: RGB labeling of K-means algorithm on SLIC feature vectors with parameter 8.

When the parameter of the K-means were to be increased, the results of segmentation of the feature vectors were improved and also for different images where there are more similar regions that are prone for segmentation are to be detected.

Segmentations as overlay examples are given below. All results included are for K parameter of 8.

Figure 5: Segmentation results as overlays. From left to right, results are from part 3 a, b, c, and from part 4.

The results applied on superpixel data set from just color (RGB) features or Gabor's convolution features gave segmentations that were decent but not sufficiently good. Combining both vectors gave a better results with meaningful segmentations to human perception. Last image is simply the result of using color feature vector without any superpixel implementation. Bare in mind that these are the results of K parameter of 8.

SLIC0

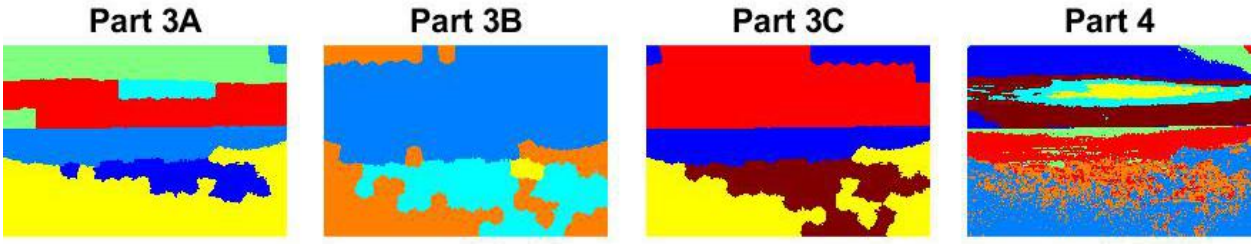

Figure 6: RGB labeling of K-means algorithm on SLIC0 feature vectors with parameter 8.

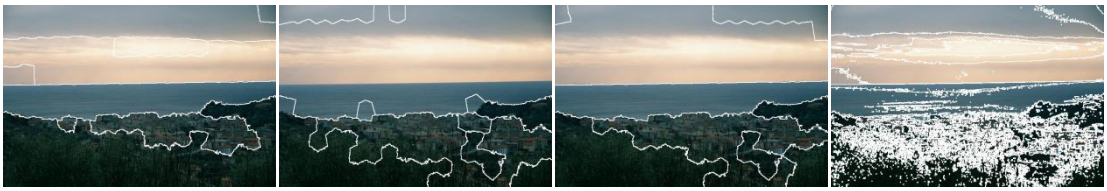

Figure 7: Segmentation results as overlays from zero parameter superpixel algorithm. From left to right, results are from part 3 a, b, c, and from part.

The only difference between SLIC and SLIC0 implementations are that SLIC0 gave sharper segmentations with edges that make sharp turns. The rest of the results are same for both of the implementations thus in SLIC0 as well the third result is the best of all.

Final Result of the Image Used On Take-Home Quiz

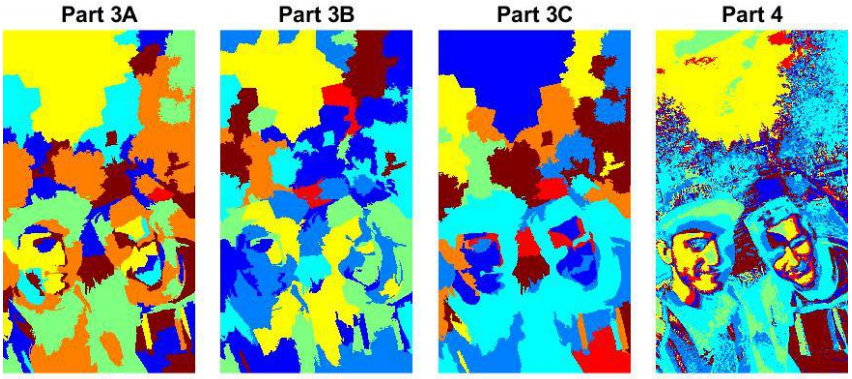

Figure 7: RGB labeled segmentation results with K parameter of 8.

Figure 8: Segmentation results as overlays. On left SLIC algorithm and on right color feature vector averaging with K parameter of 8.

As my own image goes, SLIC algorithm with 15 with K parameter of 8 gave the best result. This image also produced some difficulty since the possible regions in the image does not have similar feature vectors when compared pixel by pixel. Thus, when compared to the color feature vector implementation of the segmentations (part 4 of the homework) I believe all SLIC implementations failed.

As a conclusion, if larger superpixel count was to be used, the algorithm could have gave better results.

The rest of the results are included in the source file.

References

[1] http://ivrl.epfl.ch/research/superpixels

[2] http://bigdata-madesimple.com/possibly-the-simplest-way-to-explain-k-means-algorithm/