Segmentation

Federico Ulloa
Universidad De Los Andes
Cra. 1 18a-12, Bogotá, Colombia
f.ulloa10@uniandes.edu.co

Esteban Vargas
Universidad De Los Andes
Cra. 1 18a-12, Bogotá, Colombia
e.vargas11@uniandes.edu.co

1.. Introduction

Segmentation is one of the main branches of computer vision. It consists of determining the pixels in an image that belong to an object of interest. A wide variety of methods exist for this purpose, and one of the most popular one is by clustering the pixels of the image. There are also several methods to cluster data, so the ones used in this work will be briefly explained.

The first one is K-means. This is the most basic non-supervised clustering method. The main idea is that, given a k number of desired clusters, the algorithm puts k centroids randomly in the data. Then, elements in each cluster are assigned by finding the closest centroid with a defined distance. Then, the centroid of each resultant cluster is calculated and the process iterated until it reaches a non-changing result.

The second method is the mixture of gaussians (GMM). This methods is a generalized version of k-means. In GMM clusters are formed by representing the probability density function of observed variables as a mixture of normal densities.

Another method is the hierarchical clustering. As its name suggests, this type of clustering produces a hierarchy of clusters. This can be made by top-down or bottom up methods. Top-down starts with all data in one cluster and starts dividing them until every data is in a different cluster. Bottom-up is the opposite, starting with each data in a different cluster and then grouping similar clusters.

Lastly, watersheds is a method based on contours. The algorithm finds the regional minima and starts "flooding"the image, fomring lakes. When two lakes are about to meet, a dam is constructed in so that lakes stay independent. When the image is completely submerged, the set of dams is the watershed lines.

2.. Materials ans methods

A simple segmentation function was created with an image, a color space, a clustering method and a number of clusters as parameters. For this, a subset of the BSDS500 database was used. Depending on the color space entered as parameter, the image is converted to that requested space. Then, the image is segmented by the clustering method and number of clusters entered as parameters. For the watersheds method, some preprocessing was made so that we could obtain markers to run the algorithm with k clusters and better results. Figures 1 and 2 show the gradient and the edges obtained for this purpose in image 2, respectively.

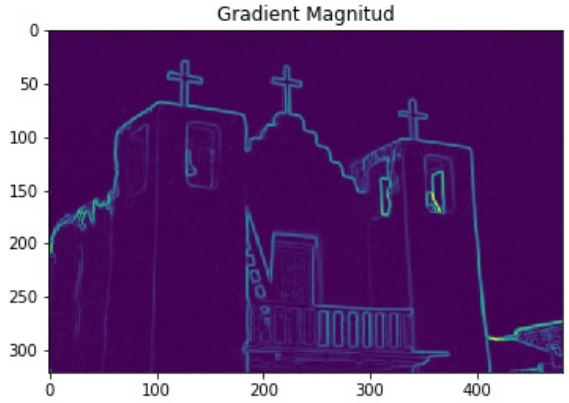

Figura 1: Gradient of image 2

In the RGBXY space, the X and Y channels had to be rescaled, so that all 5 channels were between 0 and 255. Also, in the hierarchical clustering, the images had to be rescaled because this algorithm takes a very long time to run.

Determining the number of clusters in segmentation depends on the application and method. This requires previous knowledge in the type of images that are being analyzed. Factors as the number of different objects in an image, the distribution of the data, shape and scale are things that can affect the .ºptimal"number of clusters. In this cases, experiments with different number of clusters can be done and from there, the k with better results can be chosen.

The evaluation discussed in this work is merely qualita-

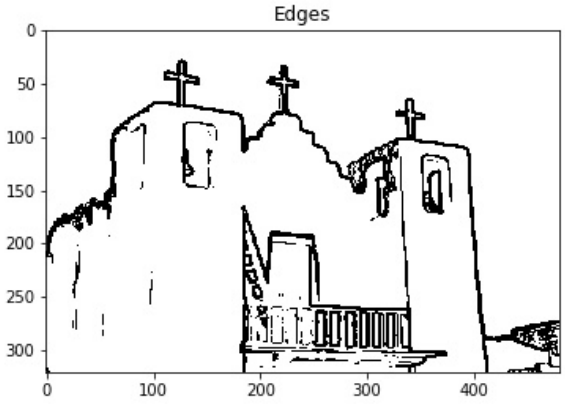

Figura 2: Edges for image 2

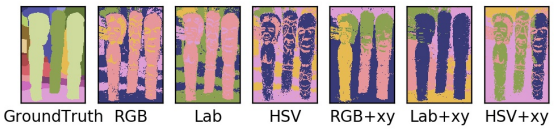

Figura 3: Results for GMM clustering in image 1

tive, as we could not implement a good working method to objectively evaluate the results in the given time. Nevertheless, possible metrics to evaluate this kind of problems are discussed later.

3.. Results

Figures 3 through 10 show the obtained segmentation for the different clustering methods in all color spaces for images 1 and 2. It is relevant to try different color spaces, as each one gives different information about the image. As shown in the images, the channels LAB and HSV show the best results in general. Also, another determining factor is the computation time that these methods represent. Hierarchical clustering takes the longest by far, as this algorithm is an agglomerative algorithm, starting with as many clusters as data. Then, K-means and GMM take approximately the same time as they are quite similar and, lastly, watersheds takes the shortest time, as it is not a random and iterative algorithm as the others. For all this, we can say that GMM and K-means are the best options, as watersheds produce big errors with this method.

The limitations of this method include the fact that a number of clusters needs to be entered as parameter, which implies that some good previous knowledge of the images is necessary. Furthermore, this segmentation method is a color based segmentation, meaning that segmentation is done with color as its only feature. This two factors contribute to a good amount of error in other type of images in which color is not sufficient to produce a good segmentation. For this reason, to improve the method, other characteristics as texture could be features to include in the data to obtain a better performance in the segmentation.

Lastly, a quantitative evaluation method can be implemented by making several comparisons with the different ground truths of every image. This comparisons can include

Figura 4: Results for GMM clustering in image 2

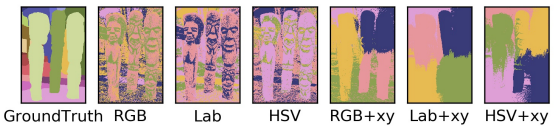

Figura 5: Results for K-means clustering in image 1

size, shape, error and other features to obtain a more liable

Figura 6: Results for GMM clustering in image 2

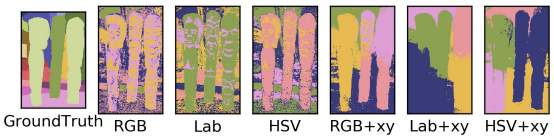

Figura 7: Results for hierarchical clustering in image 1

Figura 8: Results for hierarchical clustering in image 1

metric. [1] [2] [3]

Figura 9: Results for watersheds clustering in image 1

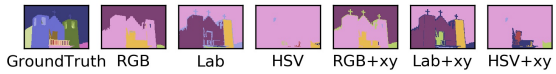

Figura 10: Results for watersheds clustering in image 2

4.. Conclusions

Clustering algorithms are very useful to perform segmentation of images. In the method used in this work, the optimal methods were K-means and GMM, as they showed better results with an acceptable computation time. Two limitations of the method used are that a number of clusters is required meaning that previous information of the image is needed, and that it is a color based segmentation. With this, we observed that LAB and HSV are the color spaces that showed the best results.

As it is not possible to obtain a definite ground truth for segmentation problems, an evaluation method is hard to define. Several approaches to this issue have been proposed and implementing one of these in the future is required to obtain quantitative results for the used method.

Referencias

[1] Crevier, D. (2008). Image segmentation algorithm development using ground truth image data sets. Computer Vision And Image Understanding, 112(2), 143-159. http://dx.doi.org/10.1016/j.cviu.2008.02.002

[2] Polak, M., Zhang, H., Pi, M. (2009). An evaluation metric for image segmentation of multiple objects. Image And Vision Computing, 27(8), 1223-1227. http://dx.doi.org/10.1016/j.imavis.2008.09.008

[3] Peng, B., Zhang, L. (2012). Evaluation of Image Segmentation Quality by Adaptive Ground Truth Composition. Computer Vision – ECCV 2012, 287-300. http://dx.doi.org/10.1007/978-3-642-33712-3_21