IOSR Journal of VLSI and Signal Processing (IOSR-JVSP)
Volume 4, Issue 6, Ver. III (Nov - Dec. 2014), PP 01-04
e-ISSN: 2319 – 4200, p-ISSN No. : 2319 – 4197
www.iosrjournals.org

Performance Analysis of Color Image Segmentation using K-Means Clustering Algorithm in Different Color Spaces

Gunjan Mathur[1], Hemant Purohit[2]
[1]*Department of Electronics and Communication Engineering, Jodhpur Institute of Engineering and Technology, Jodhpur, INDIA*
[2]*Department of Electrical and Electronics Engineering,JIET School of Engineering and Technology for Girls,Jodhpur, INDIA*

Abstract: *Segmentation is a fundamental process in digital image processing which has found extensive applications in areas such as medical image processing, compression, diagnosis arthritis from joint image, automatic text hand writing analysis, and remote sensing.The clustering methods can be used to segment any image into various clusters based on the similarity criteria like color or texture. In this research we have developed a method to segment color images using K-means clustering algorithm. K-means clustering algorithm divides the image into K clusters based on the similarity between the pixels in that cluster. In this research we have used Euclidean distance formula to define clusters in K-mean clustering. The proposed method has been applied to a variety of images and conclusions have been drawn.*
Keywords: *Clustering, Color Space, Image Segmentation,Indexing, K-Means Algorithm*

I. Introduction

With the rapid enhancement in the digital technology, the digital images play very significant role in present era. Digital image can be considered as a large array of discrete dots, each of which has a brightness associated with it. These dots are called picture elements, or more simply pixels[1]. Each pixel of the digital image signifies the color at a single point in the image (for colored images) or the gray level (for monochrome images).

Image segmentation is defined as; "the search for homogenous regions in an image and later the classification of these images"[2]. Segmentation implies the division of an image into different objects or connected regions that do not overlap. Real world image segmentation problems actually have multiple objectives such as minimize overall deviation, maximize connectivity, minimize the features or minimize the error rate of the classifier[3]. The two basic properties in image segmentation are discontinuity and similarity. In the discontinuity, the approach is to partition an image based on abrupt changes in intensity, such as isolated points, lines and edges in an image. The principle approaches in similarity are based on partitioning an image into regions that are similar according to a set of predefined criteria.

Though, extensive research has been done in creating many different approaches and algorithms for image segmentation, however, it is still not very clear to assess whether one algorithm produces more accurate segmentations than another, whether it be for a particular image or set of images, or more generally, for a whole class of images. The present researches on image segmentation using clustering algorithms reveals that K-means clustering algorithm so far produces best results but some improvements can be made to improve the results.

II. K-Means Clustering Algorithm

Clustering can be viewed as a division of data into groups of similar objects. Each group or cluster consists of objects that are similar among themselves and dissimilar to objects of other groups.

K-means clustering algorithm is a partitioning algorithm that relocates instances by moving then from one cluster to another until desired clustering structure is obtained. K-means clustering algorithm partitions data into K-clusters (C1, C2… Ck), represented by their centers or means. The mean of each cluster is represented as the center of that cluster.

This algorithm aims at minimizing an objective function, e.g. a squared error function. The objective function is expressed as [4]:

$$\sum_{\mathbf{j}=1}^{\mathbf{k}} \sum_{\mathbf{i}=1}^{\mathbf{n}} \left\| \mathbf{x_i}^{(\mathbf{j})} - \mathbf{c_j} \right\|^2$$

Where $\left\| \mathbf{x_i}^{(j)} - \mathbf{c_j} \right\|$is a chosen distance measure between a $\mathbf{x_i}^{(j)}$data point and the cluster centre cj, is an indicator of the distance of the n data points from their respective cluster centers.

The center of each cluster is calculated as the mean of all the instances belonging to that cluster using following expression:

$$\mu_k = \frac{1}{N_k}\sum_{q=1}^{N_k} x_q$$

Where, $N_k$is the number of instances belonging to cluster k and $\mu_k$is the mean of the cluster k. This produces a separation of the objects into groups from which the metric to be minimized can be calculated.

1.1 Pseudo code for K-Means Clustering Algorithm:
Input: S (instance set), K (number of clusters)
Output: clusters
Steps:
1. Initialize K cluster centers.
2. While termination condition is not satisfied do
3. Assign instances to the closest cluster center.
4. Update cluster centers based on the assignment.
5. End while

III. Proposed Method

The k-means clustering algorithm defines clusters in an image based on the similarity pattern among the pixels. K-means clustering algorithm assigns various pixels to a particular cluster by measuring squared Euclidean distance formula. The clusters so formed by K-means clustering algorithm segment the image into various segments represented by different clusters.

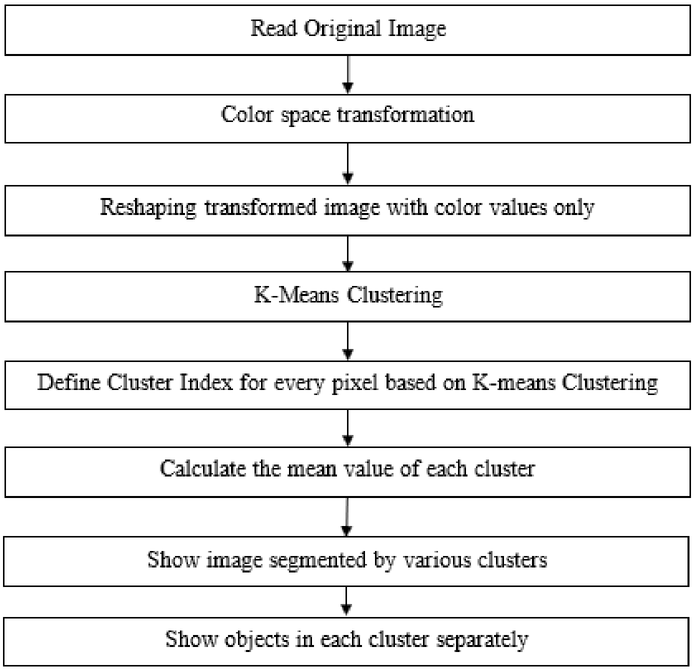


Fig. 1 Proposed Method for the segmentation of Color Images based on K-Means Clustering

The image originally fetched in RGB, has to be converted into another color space. The basic idea to segment images using K-means clustering algorithm is to make clusters based on the color value of every pixel. For this purpose, the luminance (or the variation in the brightness) of every pixel is to be ignored. The removal of brightness from any color image leaves the image with only three colors: white, blue and pink.

Since all of the color information is contained by color values layers, there is no need of luminosity layer. Therefore, we need to reshape the image matrix obtained after image transformation in color space. Only frames we need are the frames containing the values of chromaticity. As clustering is to be done on the color values of the pixels using distance formula, reshaping is again required to accommodate values of color layers in a single matrix for each distance calculation.

The K-means algorithm is then applied on each pixel of this image. K-means clustering measures the Euclidean distance among each pixel to another. K-means clustering defines clusters of the pixels that are as close to each other as possible and as far from pixels in other clusters as possible.

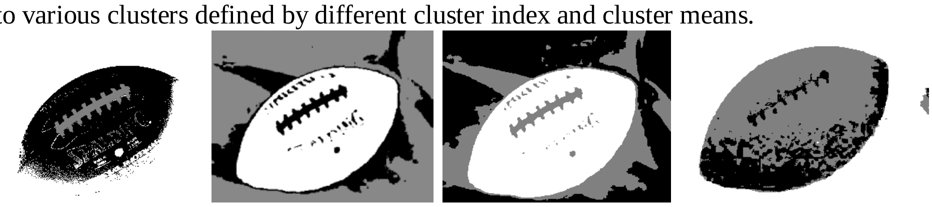
The K-means clustering returns the cluster index value for every pixel in the image. The image can be segmented by these index values into various segments or clusters.

IV. Experimental Results

(a) (b) (c) (d)

Fig. 2 (a) Original Image, Color Space Transformed Image (b) L*a*b (c) YCbCr (d) HSV

Original image is fetched in RGB color space and then transformed into different color space for the application of K-means clustering algorithm for the segmentation of image. K-means clustering is applied on pixels having values color components i.e a* and b* layers in L*a*b color space, Cb and Cr layers in YCbCr color space and Hue and Saturation layers in HSV color space. After application of K-means clustering image is segmented into various clusters defined by different cluster index and cluster means.



(a) (b) (c) (d)

Fig. 3 Image labeled by cluster index (a) RGB (b) L*a*b (c) YCbCr (d) HSV

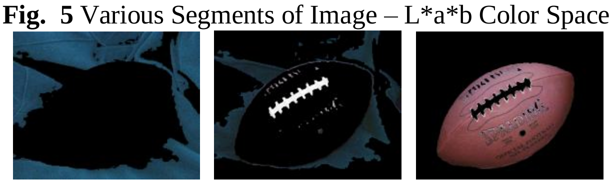
Fig. 4 to fig. 7 show the objects in different clusters after the application of K-means clustering algorithm applied on the image transformed in different color space.

(a) (b) (c)

Fig. 4 Various Segments of Image – RGB Color Space

(a) (b) (c)

Fig. 5 Various Segments of Image – L*a*b Color Space



(a) (b) (c)

Fig. 6 Various Segments of Image – YCbCr Color Space

(a) (b) (c)

Fig. 7 Various Segments of Image – HSV Color Space

V. Conclusion

In this research the proposed method of segmentation of color images, algorithm was applied on various images in various color spaces viz. RGB, L*a*b, YCbCr and HSV color spaces.It can be concluded from the study that the L*a*b color space and YCbCr color space provide best segmentation of a color image based on the color components. Among these two color spaces L*a*b color space is widely acceptable due to less execution time even in the case of large number of color components in an image.

Table1: Comparison of Image Segmentation Using Proposed Method In Different Color Spaces

Color Space	Execution Time	Image Segmentation	Remark
RGB	Highest execution time	Not Satisfactory	Not suitable for images with more color variants.
L*a*b	Least execution time	Best	Suitable for all kind of images,
YCbCr	Less execution time	Better	Suitable for images having distinct color components.
HSV	High execution time	Good	Suitable for images having distinct color components.

In future, an algorithm may be designed which decides on its own the optimum number of clusters required based on the type of image and colors used in the image. An algorithm with adaptive number of clusters may be developed to reduce the complexity and to provide better image segmentation.

References

[1]. McAndrew, An Introduction to Digital Image Processing with Matlab, Victoria University of Technology.
[2]. M. Sahu and D. K. Parvathi, "Segmentation of Colour Data Base Image by Implementing K-means Clustering," International Journal of Innovations in Engineering and Technology, vol. 2, no. 4, pp. 229-234, August 2013.
[3]. M. Lalitha, M. Kiruthiga and C. Loganathan, "A Survey on Image Segmentation through Clustering Algorithm," International Journal of Science and Research, vol. 2, no. 2, pp. 348-358, February 2013.
[4]. R. Jipkate and D. V. V. Gohokar, "A Comparitive Analysis of Fuzzy C-means Clustering and K-means Clustering Algorithms," International Journal of Computationsl Engineering, vol. 2, no. 3, pp. 737-739, May-June 2012.
[5]. R. A. Barakbah and Y. Kiyoki, "A New Approach for Image Segmentation using Pillar-K-means Algorithm," World Academy of Science, Engineering and Technology, pp. 23-28, 2009.
[6]. M. Bhardwaj, A. Walia and H. Tulsani, "Comparative Research on Fuzzy C-means and K-means Clustering Segmentation," International Journal of Computer Applications & Information Technology, vol. 3, no. 2, pp. 44-47, Aug-Sep 2013.
[7]. Chandhok, "Color image Segmentation using K-means Clustering," International journal of VLSI & signal Processing Applications, vol. 2, no. 3, pp. 241-245, June 2012.
[8]. Z. Chitade And D. S. Katiyar, "Colour Based Image Segmentation Using K-Means Clustering," International Journal of Engineering Science and Technology, vol. 2, no. 10, pp. 5319-5325, 2010.
[9]. M. K. Patel and M. H. Pandya, "Adaptive Pillar K-means Approach for Image Segmentation," International Journal of Advanced Engineering Applications, vol. 1, no. 2, pp. 23-26, 2012.
[10]. F. A. Shmmala and W. Ashour, "Color Based Image Segmentation using Different Versions of K-means into two spaces," Global Advanced Research Journal of Engineering, Technology and Innovation, vol. 1, no. 9, pp. 30-41, January 2013.
[11]. A. Yerpude and D. S. Dubey, "Colour Image Segmentation using K-Medoids Clustering," International Journal of Computer Technology and Applications, vol. 3, no. 1, pp. 152-739, Jan-Feb 2012.